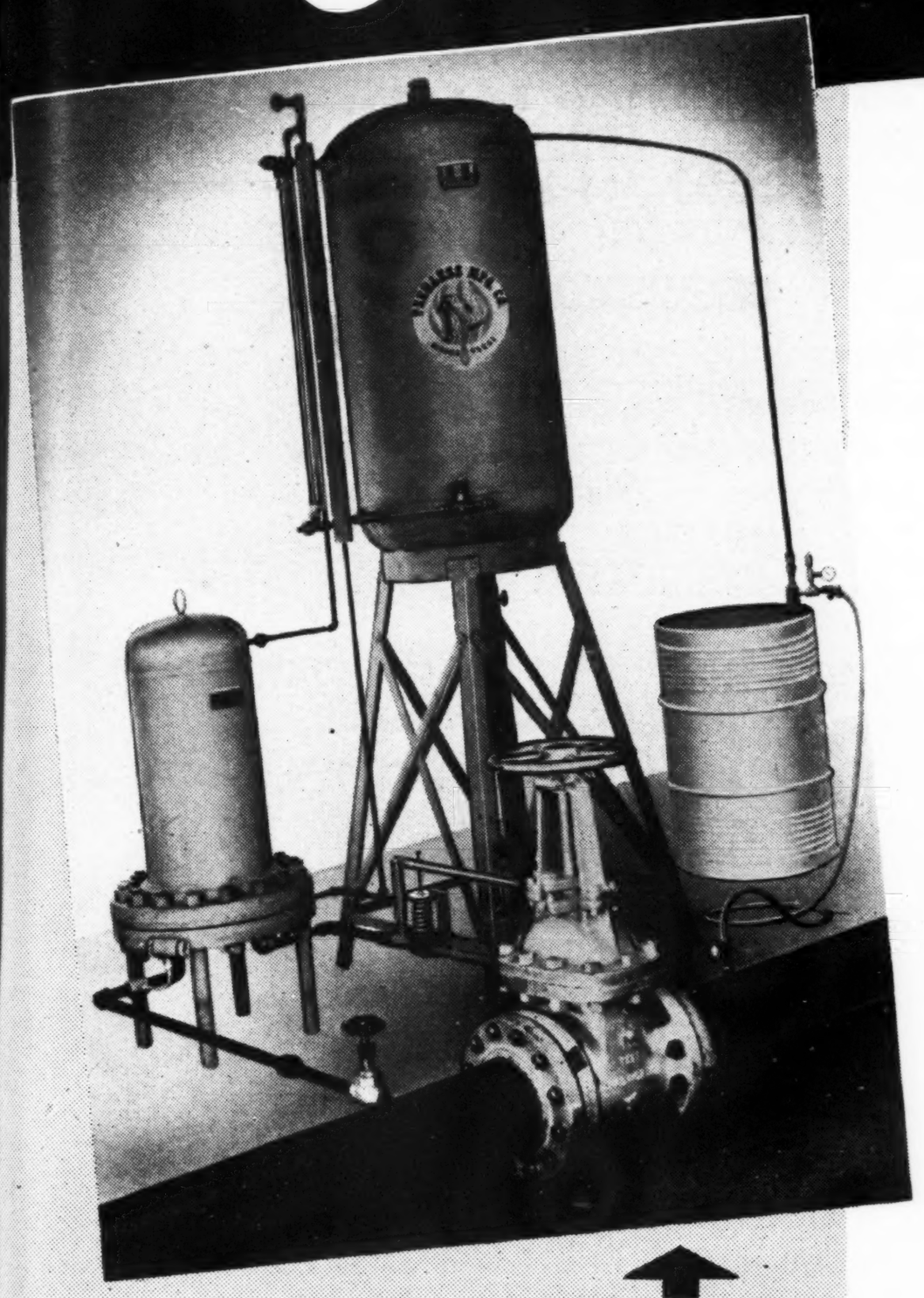
ARE YOU ODORIZING YOUR GAS?



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   ANSWER
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2. QUESTION
   We require a very accurate odorizing rate.
   ANSWER
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3. QUESTION
   Our flow varies greatly, will this affect the efficiency of the odorizer?
   ANSWER
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4. QUESTION
   What if the line pressure and temperature vary, will this effect the odorizing rate?
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5. QUESTION
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   ANSWER
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GAS

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A JENKINS PUBLICATION

Twenty-Sixth Year of Publication

May, 1950 CCA NBP **Vol. 26—No. 5**

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Highlights

NATURAL GAS, FRONT AND CENTER. This is the month of the AGA Natural Gas Department spring meeting in Tulsa, Okla. To that meeting, and to natural gas men everywhere, this special issue is dedicated.

HERE IS JUST ONE OF THE SPECIAL TREATS IN THIS SPECIAL ISSUE: Beginning on p. 31, seven experts answer vital questions on converting to natural gas.

SEVENTY-THREE UTILITIES ARE SPENDING $336 MILLION to improve plant and increase sendout this year. See pp. 41-43.

SCIENCE CANNOT PRODUCE A COAL GAS COMPETITIVE WITH NATURAL GAS. So say experts from Battelle Memorial Institute. Only producer gas (because of the cheapness of manufacture) has any chance, despite its low Btu content. Coalmen therefore must promote electricity, including railroad electrification, they said.

NEW ENGLAND HEARINGS BROKEN UP. East Tennessee's case, as well as those of three northern Ohio companies, have been severed from the principal docket in which Tennessee Gas Transmission Co. and Northeastern are seeking to carry gas to New England. Hearings are scheduled for Boston May 8.

GOOD NEWS ON EXCISE TAX RELIEF. The House Ways and Means Committee has voted to lift these wartime levies on household stoves and water heaters. These appliances were among the favored few that squeaked through. Refrigerators were yet to be considered.

SAN JUAN LINE CASE POSTPONED-- AGAIN. After convening April 17 in Washington (see p. 152), on April 21 hearings on the proposal to build a line from the "four corners" of Colorado, Utah, Arizona, and New Mexico were recessed until May 22 at the request of the commission staff.

COMMONWEALTH NATURAL WINS RIGHT TO SERVE VIRGINIA. Richmond and Norfolk will get natural gas before 1951 as the result of FPC's decision to award a certificate to the Columbia subsidiary.

THE KERR BILL IS DEAD. But no immediate extension of FPC activity into the sphere of independent production is anticipated. Although in effect affirming the commission's right to invade this field, the President intimated that he would not "object to reasonable amendments" in the future--if he deemed them necessary.

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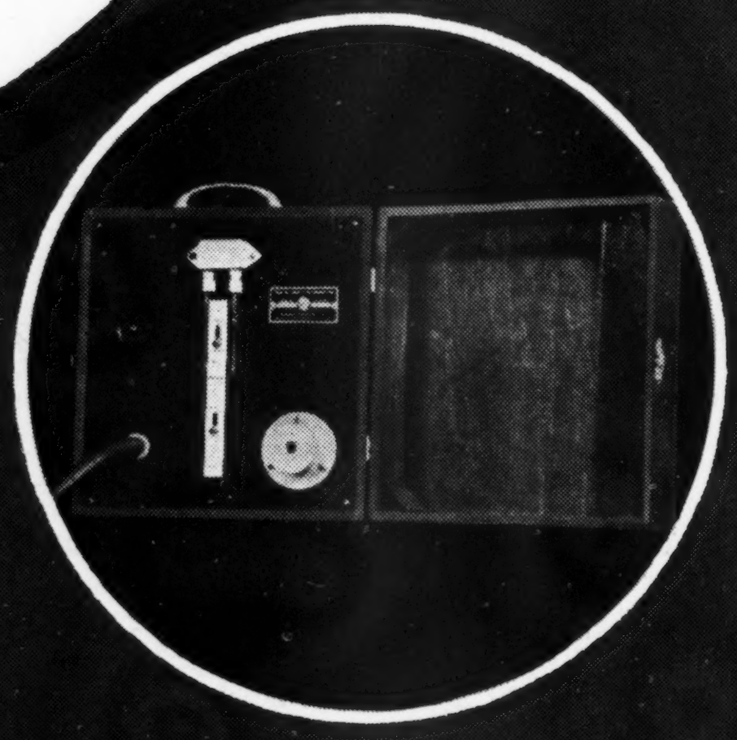

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THE WARNING ODOR FOR FUEL GASES

EDWARD TITUS

THERMALLY THINKING

Maytime

IN THE SPRING a banker's fancy turns to thoughts of the natural gas industry. There's no Bank Night or other fancy inducement necessary to persuade bankers or other smart people to show at the Natural Gas spring meeting in Tulsa this month. We're told, however, that there are so many investment bankers and other kinds of bankers expected there that someone suggested declaring a Bank Day.

The industry can well be proud of the sincere interest of the banking fraternity in its activities. The more bankers the better, and the more of the kind of people who will interest the public in buying equity securities and interest Washington in giving the holder of equity securities a better break, taxwise and otherwise, the better.

All this leads to a thought of caution. The industry is due for a steady and sound growth, already under way. But let's not move too fast. Over-glamorization should be avoided. There is a group in the public who would require only a little encouragement to become confused between San Francisco in 1849 and Tulsa in 1950, and think that a gas company would have only to dig a foot under the ground to find billions of dollars' worth of natural gas to sell at fantastic rates to poor suckers in Boston and New York.

The bankers haven't fostered this idea, nor have any of the investment fraternity, and the idea hasn't gone to the above extremes yet, by far.

But it might be a hunch, from a number of angles, for everybody to watch and check tendencies of the public to get too much of a super-super impression of natural gas. The public is sold on it now, everywhere including the Northeast, so no need to worry about that.

In one way, it's a great thing that gas has become more exciting than it used to be, as a short while ago people in the gas industry were worried about the inroads that electricity was making through being the glamorous fuel. Now gas is becoming glamorous too. But along with glamor come worries and responsibilities.

There recently has been a demonstration of how rapidly and effectively the public can become aroused with the idea of a great big powerful gas industry ready to snitch nickels out of the pocket of Joe Consumer.

And, so . . . the President vetoed the Kerr Bill.

Veto Message

OVER A CUP OF TEA, or whatever one chooses to call it, at the New England Gas Assn. meeting in Boston in March, someone asked what was likely to happen to the Kerr Bill (to exempt independent producers from FPC regulation). Our guess was it wouldn't get through all the hurdles it had to cross, this time. Just too many hurdles.

Along with the veto came a well-thought out—if one were critical one would say a well-rationalized—veto message. It probably wasn't all written in Key West. Before the veto there was one report that the President had become annoyed with the obviously inspired coast-to-coast clamor against the bill. Still he went along with the clamorers.

It can be stated that, in the Northeast, gas consumers—who will also be voters in the coming Congressional election—really were worried about the bill. Two friends walking out of Childs' on 42nd Street wanted to know how much it would raise their gas bills if the President signed it. These boys will vote in the Congressional elections this fall, and it would be very tough to convince them their gas bills might really have turned out to be lower in the long run if the President had signed the Kerr Bill.

Professor-Banker

THE ICONOCLAST PROFESSOR-BANKER, Dr. Arthur A. Smith, chairman of the Department of Economics of Southern Methodist University (also with the First National Bank in Dallas) did a good job as a catalyst at the meeting of the Southern Gas Assn. in Galveston.

One might suspect that Hugh Cuthrell of Brooklyn, president of the American Gas Assn., would have had an effective answer to him—if he'd had a rebuttal period—on the matter of whether the gas industry should go after business connected with public housing programs.

"You and I have allowed ourselves to be divided and conquered," Dr. Smith maintained.

On his next point, however, one might submit that Dr. Smith was a bit off base, when he referred to Mr. Cuthrell's advice that, since $6 billion was being spent on public housing, "Let's get in and get our share."

"Have nothing to do with it," Dr. Smith urged. Catering to such programs means submitting to the socialistic trend of dividing and ruling business, he held.

All sound thinking, Dr. Smith, except for one little fallacy: the gas industry itself didn't seek the government housing program. The gas industry is seeking and getting no government subsidy.

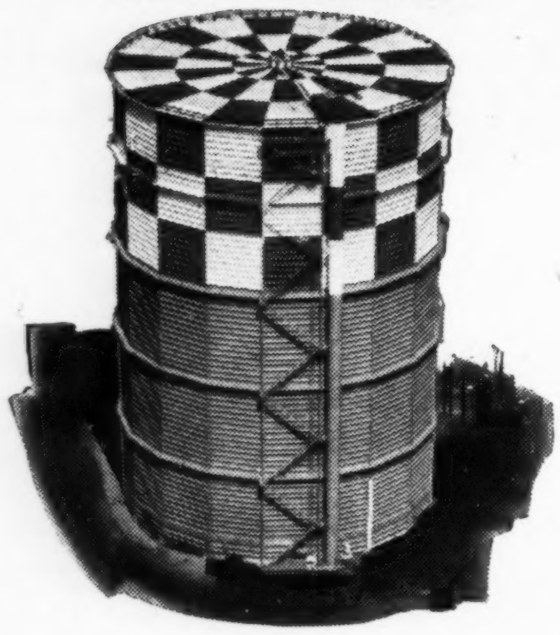
The industry, as legitimate private enterprise, will seek business in competition with the electric industry or any other supplier of fuel in both private and public housing.

Despite this obvious error, Dr. Smith made quite a creditable speech.

Plenty original was his idea for a research project in which he put his students out on the streets of a Texas city to find out how many smokers knew how much in taxes they were paying on their cigarettes. One in 25 knew it was at least as much as 7 cents. But in Texas it is "nigh on to 12 cents a pack."

His thought was to tell the public what they're paying for government.

KOPPERS WATERLESS GAS HOLDERS



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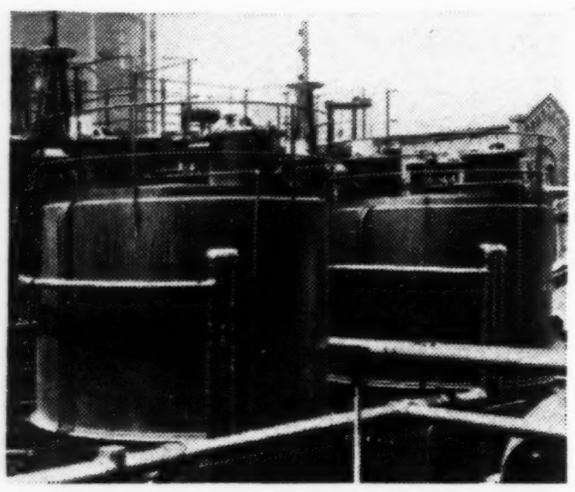

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GUY CORFIELD

TECHNICAL TRENDS

Natural Gas

As We See It. Inasmuch as this issue is largely devoted to natural gas, it seems appropriate to comment in a semi-technical manner on this oldest and newest fuel—oldest because it was known to primitive man and used in early civilizations, and newest because it is just being introduced to large areas of this country; and to perhaps commend or defend it to those who seemingly are viewing its current eastward and northward expansion with some misgiving that it is new and untried, impure, undependable and short-lived.

From the standpoint of physical and chemical characteristics, it would seem that, if we had had the choice of all the known combustible gases, we could not have made a better selection than the methane-ethane mixture which nature has prepared for us. Its heating value, approximately 1100 Btu/cu ft, is high to provide good thermal capacity through moderately sized pipes and orifices at reasonable pressures; its specific gravity, approximately 0.65 (air equals 1.00), is low enough to assist pipe and orifice capacity, but not so low as to promote leakage or make it difficult to confine at the highest pressures, or so high as to be above air and therefore tend to sink and pocket when accidental leakage does occur; it burns with a flame which is neither "hard" with flash-back tendencies nor "soft" and prone to smoke, and therefore is amenable to relatively easy adjustment for any use or process; but at the same time its combustible limits are narrow, approximately 5 to 15% in air, making it relatively safe from accident due to uncontrolled air mixing; furthermore it is non-corrosive and non-toxic and practically odorless. How much better than if nature had provided us instead with hydrogen, acetylene or hydrogen sulfide!

Those who feel it is new and untried might remember that it was first discovered in Pennsylvania and had been used in that vicinity for many years before its unprecedented expansion in the midcontinent and west; with modern methods of sulfur removal, dust scrubbing and dehydration, and high-pressure absorption to remove LP-Gas and natural gasoline, transmission line natural gas can be relied upon to be free from impurities and condensates; the vast strides that have been made in production and transmission engineering, materials and methods leave no reasonable doubt as to its dependability; and the care and skill with which reserves are explored and computed prior to the building of transmission lines, and the steady increase of these reserves in spite of the increasing usage, would seem to be a guarantee of unfailing supply for at least many decades.

As It Looks To Others. Apparently many interests outside the gas industry are convinced that natural gas is an extremely serious threat if not an acknowledged victor in the battle of the fuels. Coal has already retreated, oil is busy seeking other markets, and attention is being shown by the modern economist group who are always attempting to substitute legislation and control for the laws of supply and demand.

Two resolutions to the Senate, from Pennsylvania and Wyoming, call for investigation of the "sick" coal industry whose plight assertedly can only be cured by establishing a national control policy to balance coal against petroleum, natural gas and water power and embrace such considerations as importing and exporting and emergency stockpiling. It is also expected that the President is about to appoint a fact finding commission to study the competition among fuels as it may appear to relate to the national economy and security.

The oil refiners (as one writer expresses it), "with the hot breath of the natural gas industry searing their necks in the race for fuel markets, are getting ready to pull aside and let the newcomer through," devoting their attention to producing more gasoline and diesel oil with the expectation that by 1953 the presently contemplated *new* supplies of natural gas will be replacing 518,000 bbls per day of liquid petroleum fuel.

Also, the Independent Refiners Assn. of America has asked the Texas Railroad Commission to apply the same proration production controls to natural gas and natural gas liquids as are now applied to crude oil. The IRAA states in part:

> "The (gas) transmission lines furnishing ever-increasing amounts of hydrocarbons competing with crude oil have no restrictions other than the volume they are able to sell on the open market through the United States. While crude oil is held down to market demand and ratable taking within fields and between fields, these lighter hydrocarbons displace crude oil refinery products because of their unrestricted operations."

Television A Gas Load Builder?

A LEADING ARTICLE in the February issue of *GAS*, entitled "Where is Gas in the Television Picture?" discussed television in connection with the gas industry from the standpoint of advertising. From a completely different angle, it appears that television may have an involuntary effect as a gas load builder. An observation has come from customer service men in Southern California Gas Co. that television sets are causing an increase in gas bills. People sit up late with furnaces on, and usually have refreshments later in the evening. Also, because they are sitting quietly, they get colder and turn the furnaces up.

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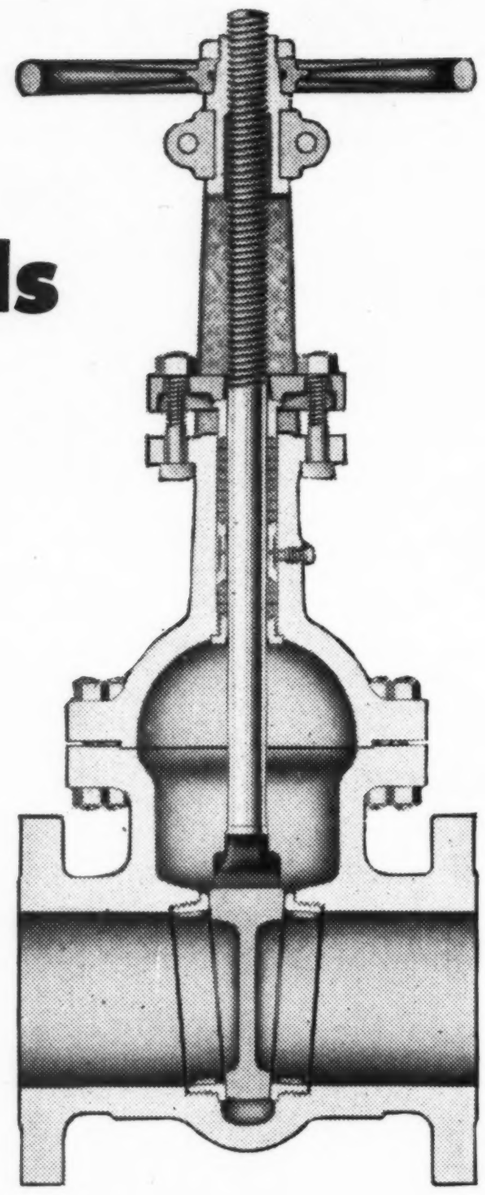

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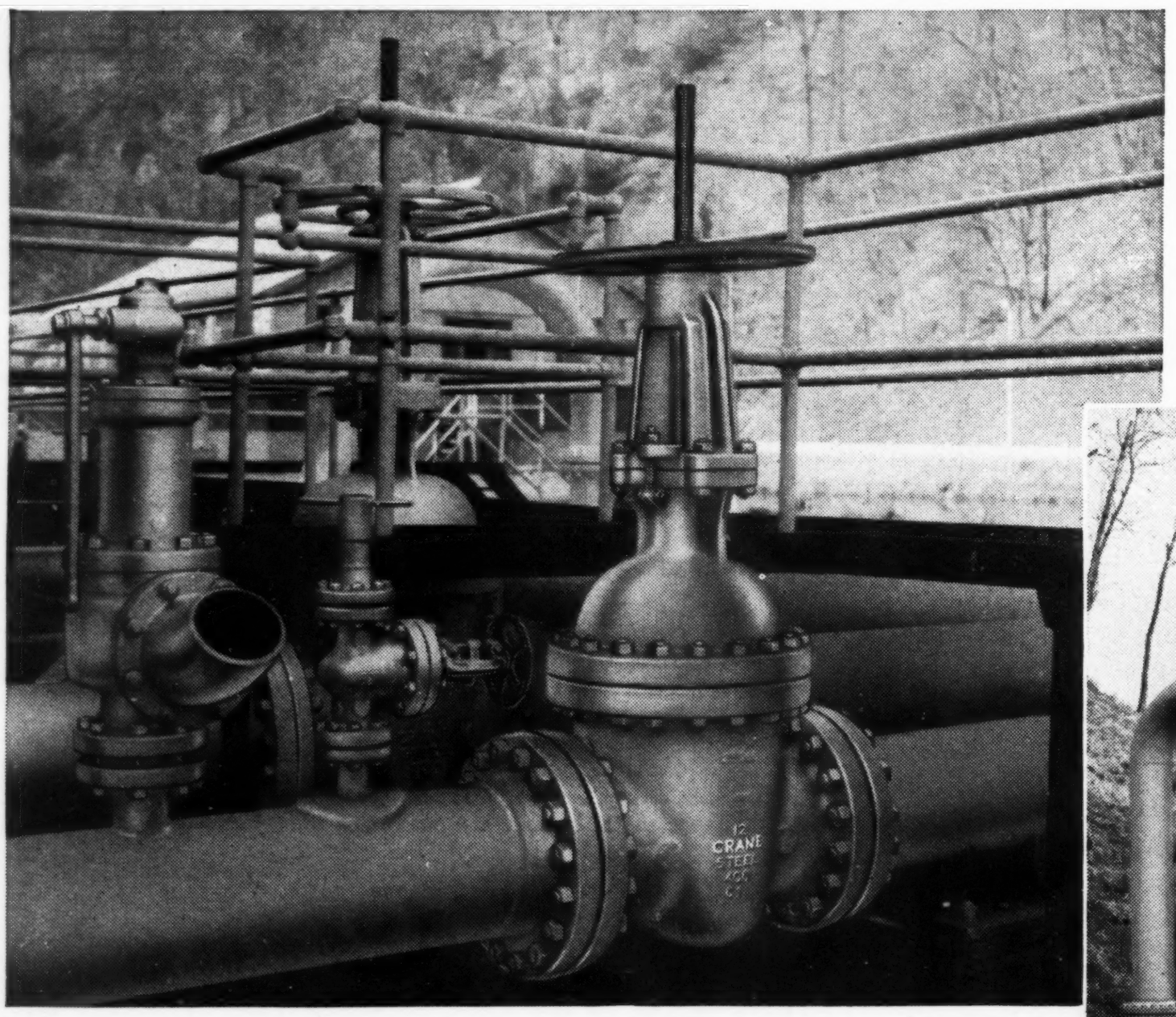

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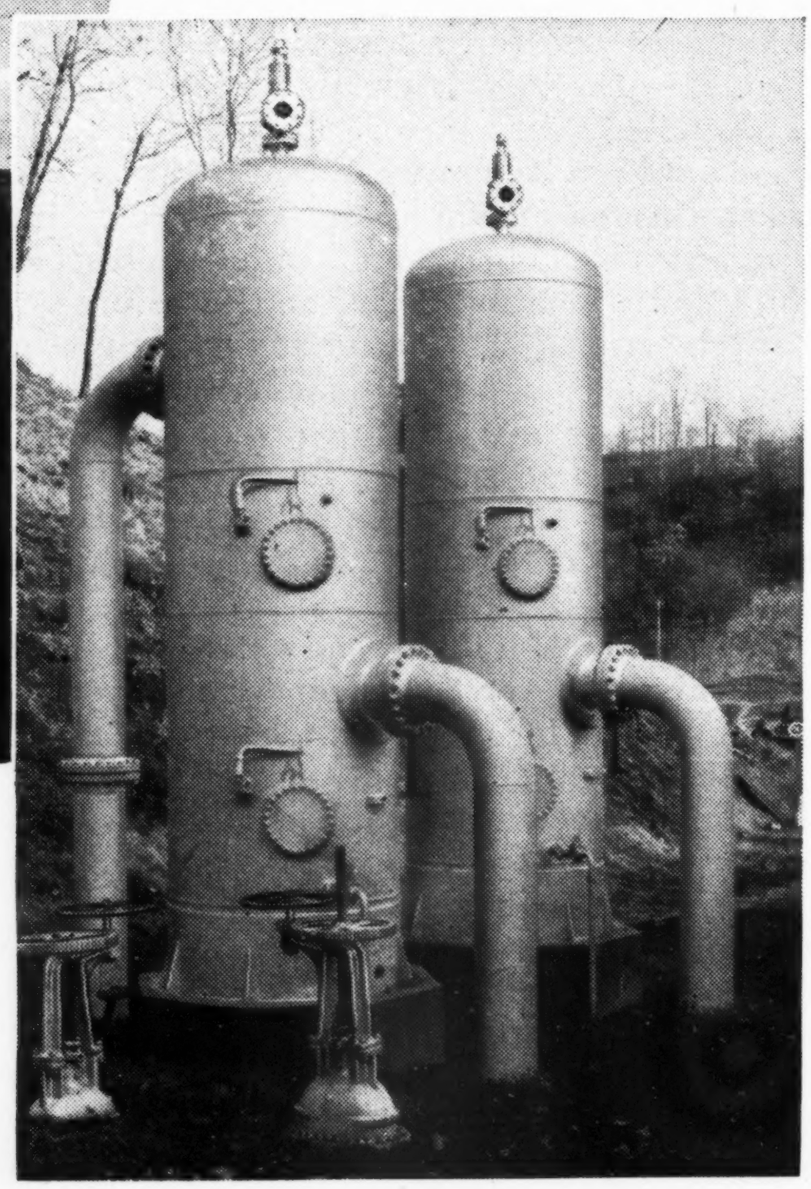

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PROMOTIONAL NOTES AND NOTIONS

Taft Talks Turkey

SENATOR TAFT'S ARTICLE "Is Truman Taking Us Down The British Road?" in the April 8 issue of *Collier's*—no doubt you have read it—sounded good even to me, strapped in an airplane seat on a turbulent flying day over volcanic Central America. The steward gave me *Collier's*, probably to keep my mind off other things.

Senator Taft, always noted for his mental honesty anyway, has no illusions about the trends of the Truman "Fair Deal" program. We in the public utility business, be it gas, electric, telephone, or transportation, are appreciative of the political-ownership threat.

In his *Collier's* article, Senator Taft sums up the situation this way, using electric power as his example, because that is the immediate Truman objective:

> . . . He (Truman) wants the government to build transmission lines, to finance generating plants for Rural Electrification Administration cooperatives, and push toward a general government system of power distribution.
>
> If the government goes as far in the power business as Mr. Truman wants it to go, private power companies will be confronted with government competition so persistent that it is doubtful whether they can long survive. The failure of private power would not mean cheaper power to consumers. It might seem to mean that, but as always when the government takes over an activity that should be run by private enterprise, the deficit is hidden, but made up in taxes. Remember, government operation does not have to be efficient to survive; therefore it will not be efficient. Generally, men will do their best work only when they must, or when there is the incentive of added reward. In government, men often stay in their jobs no matter how much they may be in a bureaucratic rut, or how indolent they may become.

Same Old Tactics

ARRIVING HOME after approximately three months in South America, and in time to see the opening moves developing in the electric quest for residential cooking, water heating, and clothes-drying loads, I am more surprised by the lack of originality in the approach than at the intensity of the effort. The latter was to be expected, because only intensive promotional effort would have a chance anyway to dislodge us from our strong domestic position.

But free wiring for electric ranges and water heaters! Heck! They used to do that 25 years ago (and incidentally capitalize the expense too). The Detroit Edison Co. announces it expects to spend around half a million dollars on free (sic) wiring this year. Whether the electric utility contributes 100% of the wiring cost or part of it, as other electric utilities have announced, it's still a price cutting dodge to minimize the price differential on an inferior appliance.

While many electric utilities, which discontinued appliance merchandising during the war years, are going back into the appliance sales field, it is significant how completely they are actively (and practically) cooperating with their appliance dealers, whose salesmen they have trained, and who are being encouraged with tempting sales prizes.

There—the dealer sales weight—is the real competitive threat, because here we have a substantial group of men who must sell electric appliances to eat regularly. As far as the electric utilities are concerned, their position is simply this. They have excess capacity to sell, and, so long as the appliances are sold to consume that capacity, they are not going to worry unduly about who sells them.

This is the only sound approach to today's domestic load-building problem.

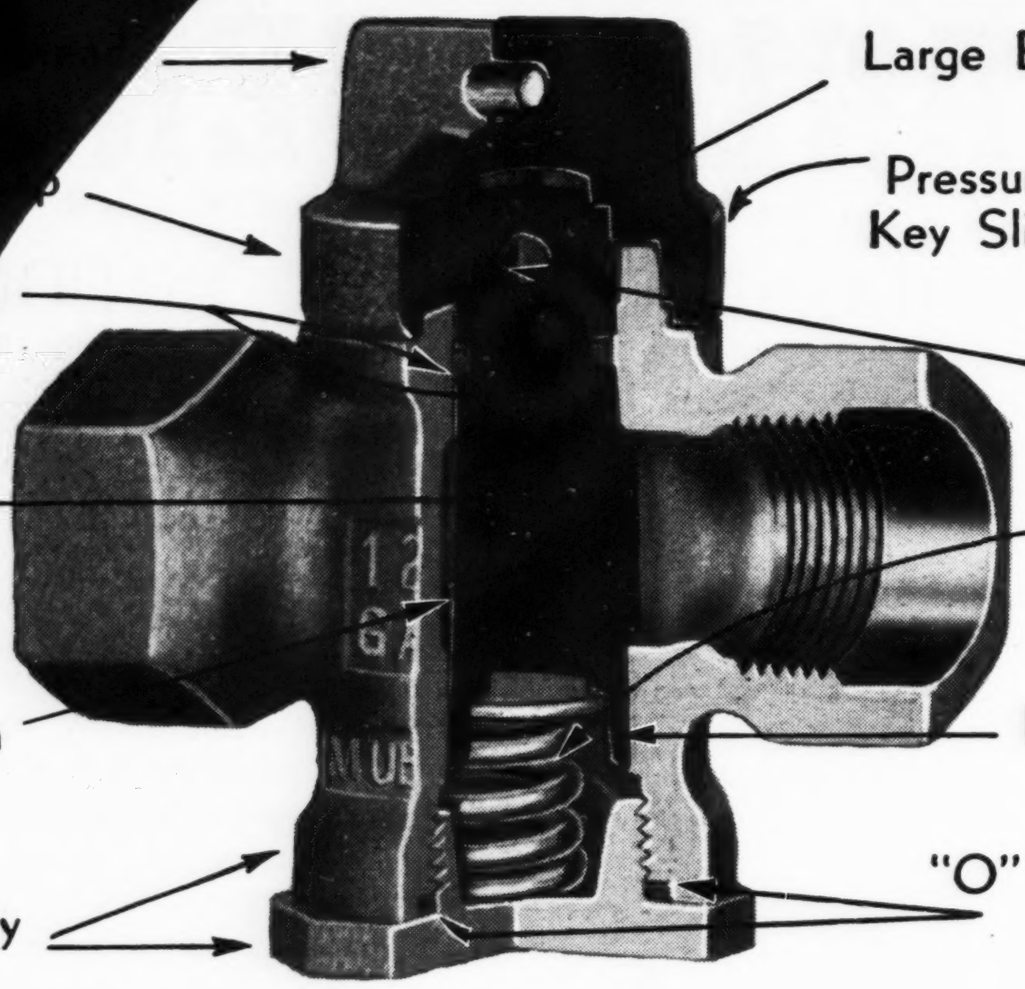
Servicio de Gaz

GAS SERVICE in South America is limited to the metropolitan areas like Santiago and Valparaiso in Chile; Buenos Aires in Argentina; Montevideo, Uruguay; and São Paulo and Rio de Janeiro in Brazil. With the exception of Buenos Aires, where the government has recently inaugurated a natural gas supply from Comodoro Rivadavia oil fields in southern Argentina, coal gas plants prevail, fueled with British and American coals. The best located gas plant is in Montevideo, Uruguay, right on the ocean (if you want to consider the Rio de la Plata at that point the open sea). There are fine, extensive bathing beaches on either side of it. It is British-owned and operated, but negotiations are in progress for its purchase by the Uruguayan government.

You run into "bottled" gas everywhere in South America beyond the gas mains. It is very popular too. There must be quite a B-P development going on in Argentina, because an Argentine business friend of mine was telling me of his efforts to meet the demands of the federal government for approximately 100,000 new cylinders this year for domestic installation.

An official of the gas company in São Paulo in Brazil told me a story that sounded all too familiar to American ears during the recent shortages. The gas company in São Paulo is having no trouble selling every cubic foot of gas it can generate. Its problem is securing the necessary equipment and materials to keep up with the phenomenal growth of São Paulo, the "Chicago" of Brazil, and the most rapidly expanding city in the Western Hemisphere.

THE *NEW* MUELLER GAS CURB STOP

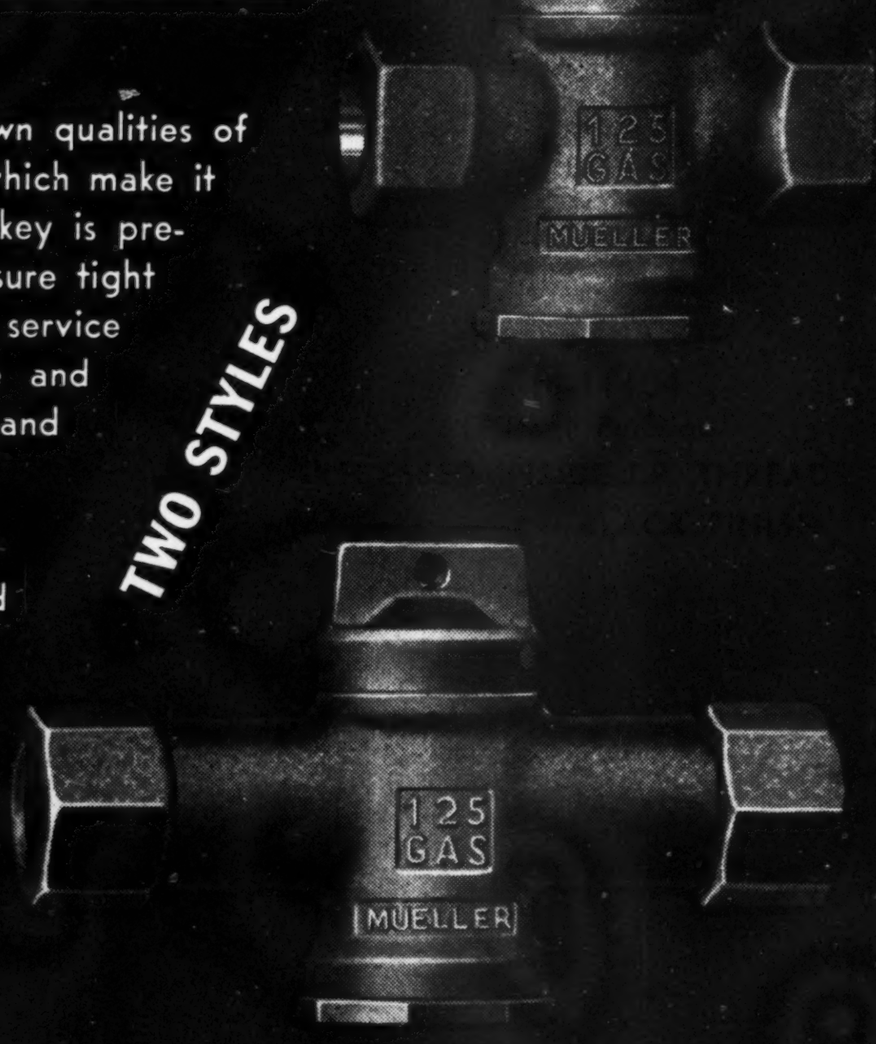


Here is the NEW Mueller Gas Curb Stop that has all the well known qualities of regular Mueller Gas Stops PLUS many new and desirable features, which make it ideal for underground installation. The heavy bronze inverted type key is precision ground to a gas tight fit in the rugged cast iron body. Pressure tight seatage is accomplished by means of an alloy steel spring, plus the service line gas pressure. Non-deteriorating "O" rings are placed above and below the gas-way, effecting a double seal from the atmosphere and giving positive assurance against top and bottom leaks.

The stop turns easily without additional lubrication as a downward pressure on the cap compresses the spring and slightly unseats the key. After operation, the spring returns the key to its pressure-tight position.

For pressures up to 125 lbs. and furnished in ¾", 1" and 1¼" sizes, either with recessed inside I.P. Threads both ends, or with Dresser Couplings Style No. 90. Order your requirements now.

TWO STYLES



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WHAT'S YOUR QUESTION?

If it's concerned with changeovers to natural gas, you may find the answer in this symposium. *GAS* herein brings to all its readers 40 pertinent questions, which were posed before a New England Gas Assn. roundtable last January—together with answers and opinions from seven experts selected by the editors.

1. PROBLEMS OF INTERCHANGEABILITY

By M. FRANK KNOY

Chief Technical Engineer
Boston Consolidated Gas Co.

1. Is it possible to use yellow-flame range burners of 530-Btu manufactured gas on straight natural gas?

In general, no.

With port area remaining constant, therm input on the natural gas would be 80 to 100% greater than the rated capacity. This would tend to produce incomplete combustion and sooting due to over-gassing alone. The tendency would be further aggravated by the slower burning character of the natural gas which might also produce lifting.

Some yellow-flame burners have been successfully used by introducing a metering spud and a modified venturi arrangement for the entrainment of primary air in the gas supply line. This has proven satisfactory in some cases and not in others. In general, it is believed that more satisfactory results will be obtained by converting such appliances to an aerated burner of standard design, or a yellow-flame burner with ports sized and spaced specifically for natural gas.

2. What appliances give the most concern for adjustment to natural gas?

In addition to the yellow-flame burners, discussed in the preceding question, trouble can be expected from laboratory Bunsen burners, dental torches, glass blowing equipment, and lamp machines. The slower burning speed of natural gas may make it difficult or impossible to obtain the necessary heat release in the available space. Radiant-fire room heaters have proven very difficult to convert in many cases. The design and arrangement of these burners do not lend themselves to adjustment to a radically different fuel. Many old or obsolete types may be in use for which new burners designed for natural gas are not available. It is believed that the outright substitution of natural gas burners, where available, will prove to be the most satisfactory method of converting this class of appliance.

Considerable trouble has been experienced in some cases with poor aeration of range top burners after conversion. It was found that leakage of combustion products from the oven was the cause of trouble. In such cases, cementing and patching the outer oven housing eliminated this recirculation of flue gas but added to the time and cost of conversion.

In at least one major conversion it was found necessary to replace all ribbon burners on space heating equipment with burners designed specifically for natural gas.

On most all Bunsen type burners (ovens, range tops, water heaters, etc.) respudding for correct therm input and enlargement of burner ports will be necessary.

3. In preparing for a changeover, what increase in Btu can be made without effect on all appliances, gravity, and chemical characteristics being held constant?

The writer knows of no published data delimiting accurately the maximum increase in therm input that can be tolerated without readjustment.

Instances are known of Btu increases from 530 to 660 with re-spudding of re-

An Exclusive GAS Panel

frigerators and special burners only, and air shutter adjustments required on only 50-60% of the remaining appliances.

In going from 530 to 600 Btu some companies have found no general readjustment necessary except on refrigerators.

4. What increase can be made in Btu requiring only adjustments to special burners such as the fixed-orifice type?

Only a thorough laboratory test with the proposed higher Btu gases can determine this accurately. (Also see answer to question 3 above.)

5. Is there an accepted procedure for changing from carburetted water gas to natural gas through the use of interim mixtures? If so, what would be the Btu values of the mixtures used?

The writer knows of no such procedure. It is believed that to do a tidy job, at least three interim mixtures and three air shutter adjustments would be required. It is doubtful if such a complicated procdure would be any more economical than the standard sectionalizing procedure.

6. Is there an interim mixture which could be used while block changeover procedure is being followed on conversion from 530 to 1000-Btu natural gas?

See answer to question 5 above.

7. Is it possible to make an oil gas cutback with blow-run or air to some Btu in the neighborhood of 600-800 that could be distributed while appliance orifices are changed and perhaps pre-adjusted for a somewhat higher Btu?

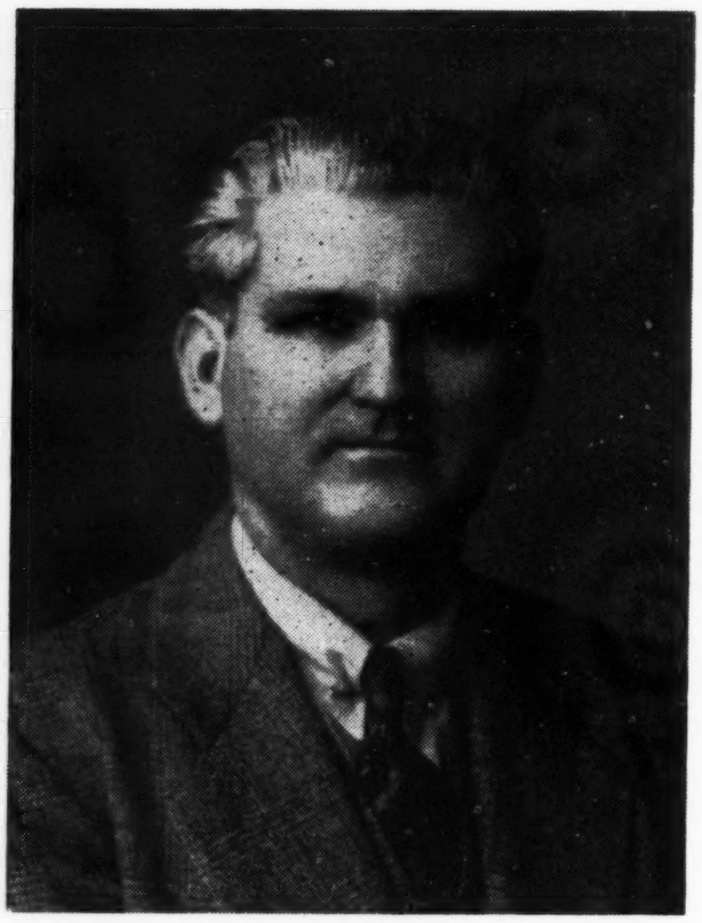
It is assumed from the nature of the question that the base gas under consideration is carburetted water gas.

Like so many other solutions involving oil gas, the answer depends largely upon the chemical composition of the oil gas employed.

In the AGA laboratories research report No. 1106-B,[1] oil gas producer gas was reported as only 50 to 55% interchangeable with carburetted water gas. Oil gas-air could be substituted only in like proportion. If either mixture was used in greater proportions, lifting was experienced on some appliances and yellow tips on others.

It seems probable that an oil gas scrubbed free from C_4 and heavier hydrocarbons could be used in greater proportions than this when properly diluted with blowrun. It is believed, however, that if such a gas were to be substituted 100% as an interim mixture, some adjustment of appliances to the interim mixture would be required. Possibly an enriched carburetted water gas would be a better interim mxture, depending, of course, upon the expected composition of the new base gas.*

8. If a company peak shaves with high Btu (1000) heavy oil gas, is this (or will it be) completely interchangeable with 100% natural gas?



M. Frank Knoy

Not in every case.[4] Some oil gases have been found to be interchangeable with some natural gases.[5] Usually 100% substitution of oil gas for natural gas will not be satisfactory.[6]

Calculations made for lifting, flashback, and yellow tip indices by the AGA formula indicate, as suggested by Edwin L. Hall, director of the AGA laboratories, that some oil gases not fully interchangeable with natural gas can be rendered so by removal of the C_4 and heavier hydrocarbons. Calculations by the technical staff of the Boston Consolidated Gas Co. indicate that some scrubbed oil gases may have their interchangeability further improved through the addition of propane or propane and inerts.

It is the belief of the writer that as the art of oil gas manufacture develops it will be found possible to tailor an oil gas to be interchangeable with a given natural gas. This may be done by, first, a judicious selection of the make oil and the operating cycle and, second, through modification of the oil gas by scrubbing out the heavy illuminants and adding propane and inerts as required.

9. How much propane-air gas can be used for peak shaving?

Since the question does not specify the base gas, both manufactured and natural gas will be considered as the base.

(a) Manufactured Gas System

According to the AGA laboratories report on the subject,[1] propane-air may generally be substituted up to 35 or 40% of the total sendout. Greater proportions might be tolerated for short periods as an emergency measure.

(b) Natural Gas System

AGA research bulletin No. 36[7] reports that butane-air may be substituted for natural gas up to 50% of sendout. It is estimated from this that for equal performance propane-air could be used up to 60%, since propane is not nearly so prone to causing yellow tips as is butane.

As an emergency measure, propane-air or LPG-air have been satisfactorily used up to 70% of the sendout.[2, 3]

10. Can we supply natural gas at 850 Btu to our customers the same as we are doing with propane-air now (850 Btu)?

From the Knoy Chart[8] we find that 850-Btu propane-air has a gravity of 1.18 as compared with .71 gravity for 850-Btu natural gas-air. The relative positions of these two gases on the chart indicate that the natural gas-air would burn much richer than the propane-air. This indicates that a complete substitution could not be made without some appliance adjustment. The same conclusion is indicated by calculations with the AGA formula.

The calculated therm input for natural gas-air is 29% greater than for propane-air, which factor alone would preclude complete interchangeability.

A simple transition procedure could be worked out, however, whereby the system could be converted over to natural gas-air with no interruption to normal service.

11. Assuming distribution facilities are ample for some time to come, is it practical to dilute natural gas with air or some other diluent to a lower Btu—say, 660—without reforming so as to delay a complete conversion?

If the present base gas is coke oven gas, carburetted water gas or a mixture of the two natural gas-air could not be substituted 100%.

The burner port area required for natural gas-air is the same as that for straight natural-gas, and is roughly double that required for manufactured gas.

Natural gas-blue gas or natural gas-reformed natural gas could, however, be used.**

12. Is natural gas completely interchangeable with 951-Btu oil gas, or which Btu-specific gravity is?

It would be misleading to state that natural gas is 100% interchangeable with a given oil gas.

*Another answer to question 7 (above) was given by George B. Johnson, Minneapolis Gas Co.: "I don't know of any oil gas cutback with blow-run or air that can be used in the neighborhood of 600-800 that could be distributed while appliance orifices are changed and pre-adjusted for a higher Btu. It is my conviction that this is impossible at present."

**Mr. Johnson (Minneapolis) was also given question 11 above, and answered: "Yes, it is practical to dilute natural gas with air or some other diluent to a Btu of 660 without reforming so as to delay a complete conversion. The success of the above depends on the condition, air adjustment and port area loading of your appliances at the present time. In any case, a preliminary port drilling and air adjustment will make such a changeover a greater success."

Natural gases from different fields vary considerably in heat value, gravity and chemical composition and, therefore, in combustion characteristics. The particular natural gas available in a given area might not be wholly interchangeable with an oil gas of 951 Btu and unspecified gravity.

Certain modifications of the oil gas might, however, make them interchange satisfactorily.

See the answer to question 8 above for further discussion of this subject.

A manufactured gas system converted to 951-Btu oil gas without a universal port enlargement might require such enlargement to take 100% natural gas.

13. In Massachusetts, where the standard Btu is 528 and natural gas might be used for cold enriching only, to displace oil, what is the maximum percentage of natural gas containing 1000 Btu which may be mixed with blue gas of 290 Btu to make a resultant gas which will not require adjustments to customers' appliances? What will be the Btu of that resultant mixed gas?

In the AGA laboratories research report No. 1106-B,[1] natural gas-blue gas mixtures are reported to be 90 to 100% interchangeable with carburetted water gases. It is believed that with minor adjustments to some appliances a complete substitution of natural gas as the enriching agent in gas manufacture could be made.

Heat value could remain the same as for present carburetted water gas if desired and specific gravity would be reduced by a few points. In general, such a gas would burn richer than carburetted water gas and would, therefore, require an air shutter adjustment on those appliances now burning with a soft flame.

For such a 528-Btu mixed gas, natural gas would constitute approximately 33.5% by volume and 63.4% on a therm basis.

After the minor adjustments to this mixed base gas one could by judicious pre-adjustment and the use of an interim mixture, convert the system to a 50-50 blue gas-natural gas base, at approximately 645 Btu and .60 gravity. In this mixture natural gas would constitute 77.5% on a therm basis.

The therm capacity of gas mains would be approximately 30% greater on this mixed gas than for the 528-Btu carburetted water gas at .68 gravity.

14. What is the best laboratory plant control method of measuring or predicting the overall appliance performance of mixed gases being sent out?

A very satisfactory method of sendout control is to maintain at the plant an appliance test floor whereon is represented each critical group or class of appliance.

During emergency periods or times when wholesale gas substitutions are being made, these check appliances should be operated on the make gas and watched continuously. Any prospect of trouble with appliances in the field will thus be indicated at once before the average quality of gas in the holders has been seriously affected. The necessary changes in heat value or chemical composition requisite to good performance can thus be made as required.

For the purpose of checking proposed mixtures in advance, it is well to have a laboratory storage holder of at least 500 cu ft capacity equipped with a stirrer or recirculating device so that uniform mixtures of any two or more gases can be made in the laboratory and their performance in critical appliances observed.[11]

On some utility systems where day to day variations in gas composition are not too pronounced, the Rochester burner has been found to be a useful tool for sendout quality control. Once the burner data for the normal gas supply, and the tolerable deviations in these indices have been established, periodic inspections of the Rochester burner around the clock will accurately reveal a too rich or too lean condition of the gas.[9, 10] The necessary changes in the production mixtures can then be made before serious utilization trouble occurs.

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2. APPLIANCE ADJUSTMENT COSTS AND PROCEDURES

By GEORGE B. JOHNSON

Manager, Customer Service
Minneapolis Gas Co.

George B. Johnson

1. What is the estimated cost per customer for (1) re-spudding and fixed shutter adjustments for, say, 750-Btu mixed gas; (2) complete changeover to natural gas?

The estimated cost per customer for re-spudding and fixed shutter adjustments for 750-Btu mixed gas or for natural gas is the same in both cases. The only difference between the two is the size of orifice used and the degree of air adjustment made. In each case the mechanics is the same and therefore the time will be the same.

By re-spudding, I am assuming that the changeover will be made by adapting the present caps. If this is the case, let us assume a hypothetical case of customers having the following appliances:

	Approximate time required for re-spudding and adjustment
(A) Range only	
Four top burners	15 Min.
Pilot light	10 "
Oven burner	10 "
Oven pilot	10 "
Total	45 "

(B) Range & water heater

Range	45 Min.
Water heater	
Burner	10 Min.
Pilot	10 "
Total	65 "

(C) Range, Water Heater, Servel

Range	45 Min.
Water Heater	20 "
Servel	20 "
Total	85 "

(D) Range, Water Heater, Servel and House Heat

Range	45 Min.
Water Heater	20 "
Servel	20 "
House Heat	30 "
Total	115 "

The cost of the above is in time only as the labor per hour varies in different localities. Assuming a labor cost of $1.50 per hour and 2.5 appliances per customer, we may assume that the cost for re-spudding and shutter adjustment per customer will be approximately 1.25 × $1.50 or $1.87 for labor, and $0.10 for materials for a total cost of $1.97. The above does not include any costs for traveling, answering customers' questions, cleaning up, moving obstructions in order to work on appliance, correcting errors, complaint costs, repair or replacement of broken parts, store room expense, transportation costs and supervision.

In case new caps are used instead of adaptors, the time saved in eliminating the re-spudding of old caps equals the additional cost of the orifice caps. In this case the labor per customer is less, but the material cost is greater. The big advantage that we found in using new caps of the recessed type over adaptors is in the quality of the completed jobs. Caps eliminated cocked orifices and plugging adaptor orifices by the housewife when removing burners by reason of the protruding adaptor scraping against dirt or grease in the process of removal or replacement.

2. What beneficial adjustments can be made beforehand—say while servicemen are installing a new range or other appliance or when they are working on some other trouble—to ease changeover load when changing from 530 to 1000 Btu?

The beneficial adjustments that can be made beforehand in changing over from 530 Btu to 1000 Btu are as follows:

(A) Drill burners to the proper port area loading (19,000 to 23,000 Btu per sq in.). In this case, care must be exercised that ports are not drilled to exceed the flash-back limits of the 530-Btu gas which will create an increase of complaints.

(B) If port area or port size cannot be increased because of the flash-back characteristics of the present gas, burner ports should be cleaned or reamed so as to obtain the greatest possible port area.

(C) Primary air shutters can be adjusted so as to allow the greatest amount of primary air without causing flame shifting.

3. When a gas company has only one storage holder into which there is one inlet on the inlet side at the plant and one outlet leading to distribution system, how can community served be sectionalized for changeover of one section at a time?

The community served by one storage holder having one inlet and one outlet gas main can only be sectionalized by installing valves at the first branch on your outlet main and then laying a duplicate natural gas line to this branch.

The above procedure is usually expensive and if the expense is prohibitive, the only alternative is to use a conversion crew large enough to complete the conversion in one week or less. This can be accomplished by newspaper and mail advertising informing customers to shut off their automatic appliances and operate by manual control. Appliances which cannot be manually operated, or produce a hardship on the customer, can be scheduled to be taken care of the first day.

4. In making changeover, what has been the size of field force per 1000 meters or on the basis of some similar factor?

The size of the field force per 1000 meters depends upon the time you use in making the changeover. You can use the factor of four (4) meters per man day in calculating your field force. For example:

10,000 Meters

2 weeks changeover time (12) days

$\frac{10{,}000}{12\times4} = 208\frac{1}{3}$ or a field force of 209 men. If one week changeover time is required the field force will be 418 men.

5. What is the best way of changing over large system when changeover would involve replacing all refrigerator burners, adjusting most commercial and industrial burners, and changing air shutters on 50% of the appliances?

The best way in changing over a large system which involves the replacing of all refrigerator burners, adjusting most commercial and industrial burners, and changing air shutters on 50% of the appliances is to sectionalize so as to complete each section in from one day to one week. One day is preferable.

3. Combination Burners Using Oil and Gas

By C. C. YOUNG

Research Engineer, Gas Service Co.
Kansas City, Mo.

1. What are the operating problems in the application of combination gas and oil burners to meet space heating peaks?

The operating problems experienced by the Gas Service Co. in installing and servicing approximately 1500 gas-oil burners during the past three years have been remarkably similar to the operating problems encountered during the pioneering days of straight gas conversion burner home heating installations. During the years of 1925 to 1930, we of the Gas Service Co. organization learned how to heat homes automatically with natural gas. Initially, our service troubles were magnified by imperfections in equipment and inexperience of operating personnel. As manufacturers gained experience, equipment imperfections were gradually reduced, and as our operating organizations gained experience, service difficulties were gradually reduced to a minimum and acceptable status.

C. C. Young

Starting with 25 handmade experimental gas-oil units in 1947, we serviced

approximately 1500 combination installations during the past winter. Service calls, when compared to the service requirements of the best straight gas combination burners, were quite high, our experience being practically parallel with that of the early days of straight natural gas installations.

Our service experience may be divided into three categories:

I. *Service on Original 25 Handmade Experimental Units.*

These installations were made principally in employees' homes, and special care was made in selecting the installation location, in the assembly of the individual burner units and in the adjustment of all controls. After the first flurry of service attention in placing these units in operation, these burners have operated, and are operating, in a very satisfactory manner from a service standpoint.

II. *Service on Combination Burners Manufactured in 1948.*

Burners manufactured during 1948 represented the first attempt at mass production on an assembly line basis on the part of manufacturers. In general, equipment embodied several new mechanisms in which imperfections developed.

Most of the combustion difficulties were solved and minor mechanical changes made in the field during the winter of 1948 and 1949, but a number of difficulties with controls were carried over into the 1949-1950 season, when the full brunt of service on 1948 production was experienced. A careful analysis, however, of each service call on combination gas and oil burners brought out the fact that a high percentage of all service calls was caused by a few new devices in the control system. It was encouraging that while still presenting opportunities for improvement, the 1949 production run gave a greatly improved service record over the 1948 production run.

III. *Service on 1949 Production Burners.*

In general, combination burners produced in 1949, incorporating minor changes in design, operated much more dependably than did burners previously manufactured. Combustion difficulties were, to a great extent, eliminated.

In the control mechanisms, however, additional improvements in detail of design were found necessary. These are currently being worked out by manufacturers with a view of improved performance to reduce field service.

To sum up our service experience, we find that many service calls have been due to imperfection of detail in manufacture or installation. Service calls are rapidly being reduced as details of design and manufacture and installation are perfected.

In the final analysis, we are heating homes with gas in mild weather and with oil in cold weather. We are doing this automatically. In general, customers are very well pleased with the service. Troubles encountered can usually be traced to inexperience. The principle of operation is sound.

Just as those gas utility companies who began promoting straight gas conversion burner installations after about 1928 were spared many of the difficulties experienced in the early days of intensive gas heating development, it is anticipated that utilities beginning aggressive promotion of combination gas-oil burners in 1950 or later will be spared most of the difficulties which arose from newness in design and assembly. It should not be assumed, however, that experience of the manufacturers can be a substitute for the thorough training of operating personnel with the new equipment.

4. Leakage, Dust Fogging, And Humidifying

By ROBERT H. TAYLOR and DONALD J. MILLER*

1. Which type of joint is best to prevent leaks—cement or lead?

We have had no experience with cement joints and discontinued the use of lead joints in 1928.

2. What is the best fogging apparatus?

A good fogging apparatus should be able to break up the oil into such small particles that the fog will persist in the distribution system for an hour or longer, it should be sufficiently flexible to produce a coarser fog if desired, it should be reasonable in first cost, simple, durable, and reliable in operation and easily and quickly maintained. Of the types on the market, each has its advantages and disadvantages. Local conditions usually will decide which is best suited for local use.

For our purposes, with natural gas available at pressures of from 25 to 40 psig, the atomization type was selected and a unit located at each district regulator station, introducing fog into the low pressure or distribution side of the district regulator. The unit is of local design and construction, consisting of a vertical tank made from a section of 20-in. steel pipe about 4 ft long. Sprays are arranged around the tank about 2 ft above the bottom. Oil is inspirated from the lower portion through outside connections to each spray and is atomized tangentially, the larger particles striking the tank wall and returning to the bottom for recirculation. Fog passes to the distribution system through a 4-in. connection in the top of the tank.

Initial cost of the unit is low, operating expense is negligible and maintenance requirements are reasonable. A fine, persistent fog is produced and actual tests show that it will remain in suspension in the mains for as long as 3 hours. By using an oil soluble dye, such as DuPont Sudan III, and a tar camera, fog has been found at distances of three miles from point of injection. Visual inspections of main and service interiors during construction and maintenance work show a good oil coating over the entire surface.

For our requirements, this type of fogging unit has been quite satisfactory.

3. How effective is oil fogging of natural gas to keep down "unaccounted-for" in a system which is presently in good shape?

Oil fogging is usually quite effective in keeping down leakage in a system which was in good condition at the time natural gas was introduced and fogging started, provided that the fog is introduced at proper locations and in adequate quantity. Our experience has been that proper fogging of natural gas will hold the average leakage per joint almost the same as it was with manufactured gas if pressures remain about the same. We do not believe that a system which is allowed to dry out and develop excessive leakage can be brought back to its former leakage level by delayed adoption of oil fogging. In other words, fogging will minimize leakage increase but is not effective as a means of reducing leakage.

*Mr. Taylor is supervisor, gas distribution, Public Service Co. of Colorado. Mr. Miller is gas engineer with that company.

Donald J. Miller

Robert H. Taylor

4. Is it necessary to resort to the use of products such as Carboseal in addition to fogging?

Our experience with Carboseal is quite limited. In the few instances where it was tried, results were fairly satisfactory.

We have found that adequate fogging will prevent any appreciable increase in joint leakage, but that it is not practical to attempt to reduce joint leakage by excessive fogging. In situations where dry joints and high leakage exist prior to introduction of natural gas, it might be economical to use Carboseal to make a quick improvement in the leakage figure. We do not believe, however, that both need be continued.

5. Is the humidification of the gas a benefit?

Humidification of the gas is a benefit in controlling leakage. As example, in one of our properties no treatment of the gas was carried on when natural gas was brought in and leakage increased from a base figure in the first complete month of natural gas operation to 7.2 times base in the corresponding month one year later. Correction involved bell clamping all cast iron joints. In a second property, humidification was started with the introduction of natural gas and the increase in leakage in the first year was in the vicinity of 50%.

Careful attention must be given humidification operations as ground temperatures drop, otherwise an excessive number of frozen services will result.

6. What type and make of fogging apparatus is recommended? Where should it be located in the system?

There are two general classes of oil foggers, the hot oil type and the atomizing or cold oil type. Selection depends primarily on local conditions. As example, cold oil foggers require gas for atomization, at pressures 10 psig or more above that in the main to which the fog is to be delivered. Further, the volume of atomizing gas, which may be as high as 5000-6000 cfh, might cause over-pressuring on off-peak hours in certain situations. District regulator stations in our systems supply up to four square miles of distribution area, with minimum hour load demand considerably in excess of gas volumes required for operating the fogger. The hot oil fogger requires a source of heat.

Local practice has been to place fogging equipment at district regulator stations, where gas from a 40-psig line is reduced in pressure and delivered to the low pressure system. Fogging into intermediate or high pressure lines is not satisfactory, as excessive condensation occurs in the higher pressure lines and the amount of oil which enters the low pressure system is inadequate.

7. Hot oil fogging is now being done at holder stations at the rate of ½ gal. per MMcf. Can this rate be increased? How much? Will additional fogging stations be advisable?

Experience has shown that a dry natural gas will retain as a vapor about one gallon of fogging oil per million cu ft at a temperature of 60°F or about half this amount at 40°. This fogging oil in vapor form will not condense and deposit on the insides of the main and services except in the colder portions of the system. For this reason, it is usual practice to fog dry natural gas with more than 1 gal. per MMcf.

With manufactured or mixed gas not fully saturated with oil vapor, effective fogging would require adding enough to complete the saturation plus an excess to remain as fog, to drop out along the main.

In theory, it is possible to calculate how much increase in fogging rate can be made, but the simplest and most effective method is to increase in steps of a quarter or half gallon per million and set the top rate through study of drippage, amount of fogging oil in meters and appliance adjustment service orders.

An oil fogging station is usually located so that fog reaches the extremities of the distribution system served by that station on days of average load. A change in conditions which would substantially increase the time required for gas to reach the system extremities might require additional stations to obtain fully effective fogging.

8. What is used for fogging? Why fog?

Fogging is done with an oil which is non-corrosive, inert, free from sulfur and low in volatiles. During recent years we have used No. 720 Fogging Oil, produced for this purpose by one of the major oil companies. Our specifications require no elementary sulfur, sweet by doctor's test and to be non-corrosive on a copper strip immersed in the oil for 24 hours at 150°F. A one quart sample is provided for us to test prior to car-lot shipment.

The purpose of oil fogging is to develop and/or maintain a slight coating of oil on the interior surfaces of the distribution system to retard corrosion, prevent drying out of the jute in bell and spigot joints, seal small leaks, minimize the movement of dust and rust and to some extent benefit meters and house governors by preventing diaphragms drying and shrinking.

9. What is the best procedure to follow before the introduction of natural gas to prevent excessive "unaccounted-for"?

If natural gas were to be introduced to replace manufactured gas in one of our properties, we would first decide what distribution pressures would be used. If a pressure higher than standard low pressure was selected, leakage survey and correction would be pursued more vigorously. Also, any required installation of house regulators and changes in type of meter would be completed ahead of the changeover.

Irrespective of any distribution pressure change, a detailed leakage survey of the system would be made, using combustible gas detectors, barring to the main at intervals of 50 ft or less, on services where they join the main, adjoint to structure entrance and at intermediate points of 15 to 20-ft intervals. A classification would be made of discovered leakage on both intensity and relative hazard bases and prompt correction would be made of locations

where potential hazard is greatest and where leakage loss warrants corrective expenditure. This leakage survey would be set up on a continuing basis, giving consideration to soil condition, electrolysis, system pressures, system age and similar factors. As example, in our Denver system the intermediate pressure system (15 to 100 psig) is surveyed at least twice annually. Low pressure systems in congested areas or where corrosion or electrolysis is above average in severity are generally on an annual basis. In residential districts with good soil conditions, periods between inspections are greater.

Arrangements would be made for the introduction of an odorant beginning shortly after the adoption of natural gas, to produce a gradual change in odor from that of the old manufactured gas to the new. If mixed gas were to be served, a preliminary study would be made to determine if odorizing is necessary.

Provisions would be made for oil fogging to start with the introduction of natural gas. Drip location, capacity and pumping schedule data would be reviewed.

An investigation would be made of materials which are normally exposed to the gas, such as valve stem packing, valve lubricants, meter diaphragm oil, pipe joint dope, range cock greases, etc., to determine if they are suitable for use with natural gas.

10. What is the best pipe joint to use for natural gas?

In 1928, when natural gas was introduced into the Denver system, we discontinued the use of lead joints in distribution work. At that time we standardized on mechanical type, rubber gasketed, bolted gland joints in cast iron pipe. Steel pipe is joined by screw threads, by welding, and by compression couplings. Following are excerpts from our operating manual in this respect:

High (over 100 psi) or intermediate (15 to 100 psi) pressure mains shall be of steel pipe joined by welding and compression couplings.

Inches (15 to 83-in. w.c.) or pounds (3 to 15 psig) low pressure system mains, when of 2-in. steel pipe, shall be joined by welding or by screw coupling, and by compression couplings. Steel pipe of 3-in. or larger size shall be joined by welding and compression couplings.

Inches or pounds low pressure mains, when of cast iron, shall employ mechanical type joints with rubber gaskets and bolted cast iron glands.

11. What is the best way to handle the problem of corrosion, dust, and dirt in the mains, resulting from 100 years

of coal gas and water gas operation?

The nearest approach we have to this situation is in Denver, where portions of the system were 50 years old at the time natural gas was introduced. A low Btu mixed coal and water gas had been served. Conversion to a 1000-Btu natural gas decreased volume of gas delivered for equivalent operation, gas velocities were lowered and tendency to move rust and dust was diminished. This condition existed until load growth brought the peak hour delivery above the maximum which had occurred with manufactured gas. During that period, the tars dried out, in some instances crumbling into loose material which moved later, but in most cases forming a hard substance which remained in place. As load increased there was some movement of rust and dust and a few partial or complete stoppages occurred, but the number never reached a critical point.

Subsequently studies were made to determine if it would have been more economical to carry on an extensive main cleaning program prior to introduction of natural gas. The conclusion was reached that both cost and customer inconvenience would have been greatly increased by prior work of any consequence which would involve cutting out sections of main and cleaning them.

Were we to do a similar job today, we would make a complete pressure survey along principal feeder mains and clean only those sections where excessive drop was indicated.

12. What are some of the distribution problems that are peculiar to natural gas where proper fogging is provided to take care of leaks and dust?

In a distribution system which is converted from manufactured to natural gas and where proper fogging is provided to control leakage and dust, the major problems are usually those of determining the best way to meet load growth. Assuming that rates will be such as to encourage attachment of space heating load and of high demand-high consumption industrial and commercial processing loads, problems to be solved include:

Distribution System Pressure. Will the system be operated at standard low pressure or will the pressure be raised, requiring installation of house regulators and possibly a change in type of meter. If system pressure is to be increased, an analysis should be made, balancing the capacity developed per investment dollar against increased leakage loss, operation and maintenance expense.

Regulation of System Pressures. If higher distribution system pressures are to be employed, possibility of utilizing automatically controlled station regulators to deliver pressure proportionate to the instantaneous demands of area load should be considered. As saturation of heating load increases, regulation problems become more acute because of increased spread between maximum and minimum hour demands.

Reduction of Leakage Losses. Despite conditioning activities, including oil fogging, water saturation, etc., experience has generally been that leakage loss increases after conversion to natural gas. If conversion and load growth are accompanied by increases in distribution system pressures, as is frequently the case, the problem of controlling leakage losses becomes more acute and usually requires development of a systematic, effective leakage survey method, close regulation of system pressures and particular attention to a proper degree of odorization.

Large Load Attachments. Attachment of large loads to a low pressure system frequently requires heavy investment in main capacity and almost always introduces troublesome problems in pressure regulation. If the design of the system permits, high demand loads are most simply served, and at less investment cost, if they are attached to intermediate pressure transmission mains.

Future Expansion. A long range plan, even though it may be expensive to develop, is almost always a necessary and highly profitable investment. Such a plan should consider feeder main reinforcements in old areas, feeder main extension into new areas, the transmission mains and regulator stations necessary to supply the ultimate area. Base design figures, such as load per customer or per foot of distributor main should be carefully reviewed, to provide for the expected increase in space heating saturation and similar factors.

Metering and Regulating. Under certain conditions, it is economical to revise meter and regulator age change and repair schedules. In many instances, age change periods can be materially lengthened without decreasing average accuracy.

Appliance Operation. Natural gas is slow burning and lower mixture velocities are necessary to prevent blow-off. Flash back troubles are considerably reduced. In some cases pilot lights become unstable, especially with natural gas having a high inert content. Gas conditioning, such as fogging, has little

effect on appliance operation. Tar and gum troubles diminish and eventualliy disappear. Corrosion from flue products is usually decreased. In the overall, introduction of natural gas reduces the number of utilization problems.

13. We are experiencing trouble in our distribution system from accumulations of rust. This is manifested in plugged service pipes. Will the introduction of natural gas in quantities up to and equal to 50% and 100% aggravate this condition? Can the movement of this rust be controlled by fogging?

Introduction of natural gas in part or in whole should not increase the rate of interior rusting of a distribution system. Natural gas normally has little if any oxygen. It is probable that the interior rusting rate will be decreased.

Fogged oil will hold in place particles of rust which, if dry, would be carried along the main. However, it cannot be considered as certain that fogged natural gas will reduce rust movement under that which occurs with manufactured gas, velocities being equal, as it is possible that the condensate or drip juice now wetting the rust is as good or even a better holding agent than fogging oil.

It would seem worth while to make some tests to find out how effective is the present wetting agent.

5. NATURAL GAS' EFFECTS ON METER PERFORMANCE

By G. B. DUSHANE JR.

Manager, Midwest Division
American Meter Co. Inc.

In answering the group of questions under Category 5, Mr. Dushane chose to submit this manuscript. For specific questions see article on page 40.

G. B. Dushane Jr.

There are two considerations which generally affect meter accuracy. One of these would come under the general heading of a lack of equilibrium in the system, generally caused by various factors. The important ones in this case are as follows:

(a) Condensate
(b) Water and water vapor
(c) Temperature
(d) Pressure
(e) Impurities

These factors affect meters principally because of the following changes which take place within the system:

(A) From condensing to non-condensing conditions.
(B) From non-condensing to condensing conditions.

They are affected by saturated or unsaturated conditions and changes from higher to lower or lower to higher relative humidity.

The other factor affecting meter proofs is purely mechanical and has to do entirely with the proper maintenance of meters.

In the first place, we would like to note that, generally speaking, after an equilibrium of conditions is accomplished, the distribution of natural gas has generally been found to have beneficial effects on meter accuracies. This condition can be expected to accrue whether straight natural gas or a mixture of natural gas is distributed and is occasioned by the resultant effect of natural gas which tends toward continued equilibrium in the system. With this thought in mind, we wish to stress that the results of a changeover to natural gas, either in straight or mixed form, is not a product of natural gas itself but rather a product of the transition in the system from an unstabilized condition to one in which a rather permanent degree of equilibrium has been accomplished.

Experience has indicated that in most systems there are certain locations, districts or zones where meter performance is generally worse than the average for the entire system. These conditions are found in most manufactured gas systems and the effects are present even before any change is made to natural gas, and it must be assumed that these zones are the result of critical concentrations of the above-mentioned factors, namely, condensate, water vapor, and impurities, generally aggravated by unstable conditions of temperature and pressure.

In our opinion, these conditions are generally aggravated by a change from a saturated or partially saturated condition to an unsaturated condition which usually follows in some degree a change to natural gas, and which has a tendency in all cases to stabilize the system on an unsaturated basis. The most important factor in considering the changes which will take place in the system, after natural gas is substituted, is the condition of the system under the previous gas conditions. The more unstable the system is prior to natural gas, the more pronounced will be the effect of the changeover. These conditions may vary in unknown degrees from one where the primary gas was distributed under high pressure, which should result in a stabilized system and, therefore, should show minimum effect on a changeover to natural gas, to one where the system is extremely wet, either in whole or in part, and where the factors of condensate, water vapor, and impurities are all present. In cases where various types of distribution are found in the same system, or where various types of gases are distributed in certain districts of the same system, these districts should be considered separately.

Separate Studies

As no two systems are exactly alike, to attempt to evaluate the effects of a changeover to natural gas, it is necessary to study each system separately. This study should include a consideration of the type of gas distributed, the type of pressure conditions under which it is distributed, namely, whether low pressure, intermediate pressure or high pressure, and consideration should be given to the type of meters in use and what maintenance they have received and in what condition they are. It is desirable to accumulate as much historical data as possible. This historical data should embrace any changes in manufacturing or distribution practices, with the dates that they took place, as well as historical data on the meter proofs resulting from any changes in distribution practice or in meter maintenance practice.

The general effect of changes from condensing to non-condensing conditions has been substantiated by a number of changeovers for a rather long period of time and this type of change generally produces a decrease in slow

meters and an increase in fast meters as its primary effect. This condition can be expected to appear in varying periods, ranging from possibly six months up to one to two years. The effects will vary directly with the percentage of condensing which took place in the primary gas. In extreme cases where a large concentration of impurities is present, a secondary effect will eventually accrue, due to the deterioration of the diaphragms, with resultant leaks caused by the diaphragms hardening to the point where cracks and holes will appear. We have seen some extreme cases under small plant operations, coupled with improper meter maintenance, where the diaphragms will begin to deteriorate entirely in as short a period as six months. The primary reason for this deterioration is the presence of gum-forming impurities, which tend to harden when the light hydrocarbons, which have acted as solvents, are no longer present. When this condition is present, we have never seen any satisfactory solution except the removal of the old diaphragms and replacement with either new diaphragms or new meters.

Corrective Methods

We would like to discuss some of the various corrective measures which have been utilized most effectively and also to touch on some corrective methods which have not proved of much benefit. In the case of companies which have distributed manufactured gas under high pressure directly to their customers or in cases where gas has been transmitted by high pressure and delivered into a low pressure system for distribution, the effects of a changeover to natural gas could be expected to show the minimum effect on both meters and regulators. In most instances where this type of distribution has been used in the primary system, the effects on meter proof have been negligible and companies have found that a minimum of corrective measures have been required.

In the systems where the primary gases have been clean and a minimum of impurities were present, even though distribution was by low pressure, some companies have been able to equalize their system without the necessity of changing meter diaphragms, although in our experience, these cases are in the minority. Certain companies which would fall within this category have reoiled their diaphragms with fair success.

Meter Changes

In cases where natural gas is to be mixed with manufactured gas, either directly or through reforming, the amount of meter changes which will be necessary would have to be determined in each individual case and would depend largely upon the type of primary gas, its saturation, etc., with relation to the saturation of the mixed or reformed natural gas. It is impossible, in our opinion, for anyone to generalize in this connection, as each individual case will be different and must be carefully studied.

In the case of systems which have a very wet, unstable primary condition, where impurities are prevalent, it has been our experience that it will be necessary to replace all meter diaphragms. Attempts have been made to dry out diaphragms in such instances and then correct the condition by re-oiling, but where a high percentage of gum-forming constituents is present, our experience would indicate that this method has not been generally successful, and, in most instances, where it has been tried, the companies have had to eventually replace the diaphragms. Some companies that had concentrations of impurities in their gas attempted, in addition to drying out the diaphragms, to remove gums from the leather with solvents. In cases where the gums had started to harden, our experience would indicate that this has not been successful.

In some of the early changeovers to natural gas, many companies attempted to dip their meters. This consisted of putting a quantity of oil in the bottom of the meter cases, in the hope that, as the condensates and water vapors were dried out of the diaphragms, the reservoir of oil in the bottom of the meter would be picked up by the diaphragms through capillary contraction. In every case that we know of where this method was tried, it proved to be unsuccessful and the companies had to finally either re-oil the diaphragms by complete submersion or else had to replace the diaphragms eventually.

Leaving Meters Open

One of the methods which has been used in determining the effect of condensates and impurities in meter diaphragms has been to inspect the meters from various districts immediately upon removal from the system and to leave the meters open to the air for a sufficient period of time to allow the solvents to evaporate. This would eventually prove the presence of gum-forming constituents. Another method which has been tried is the use of glazed meters in various districts, which have been watched for bleaching, and this in some instances has been very beneficial in determining the districts which should be corrected first.

We would like to touch a moment on the effect of oil fogging, either hot or cold, as well as steam hydration and its possible beneficial effects on meter diaphragms. I think it is safe to say that neither of these methods has been beneficial to meter diaphragms. In our opinion they are done to overcome other changes which take place in a system which has changed from saturated to unsaturated gas and in many cases they are very necessary from the point of view of dust trouble, joint leaks, etc., but they are not designed to overcome the effect of changes in saturation in gas meters. It is true that in some instances fogging oil will be found in meters adjacent to the point of fogging, but there is very little uniformity in the quantity of the oil deposit in the meters. We have seen some where the meters were saturated with oil close to the foggers and on the same system, further from the foggers, we have found meters with no noticeable effect from the fogging oil and we would not recomend this practice as a correction for meter troubles.

Replacing Diaphragms

I think we would be negligent in this discussion not to mention the possibility of replacing meter diaphragms prior to a changeover. In the case of leather diaphragms, the results of changing them very much in advance of the change to natural gas will not be beneficial if the system is extremely unstable or if a high concentration of gum-forming constituents is present. However, it is possible in some systems to start the reconditioning program in advance of the time of changeover. Several companies in the Middle West, particularly, have been installing synthetic diaphragms for a number of years prior to the changeover, in the hope of avoiding the necessity of having to recondition these meters after the changeover.

From our experience, the effect of natural gas on leather diaphragms has been such as to give a diaphragm life expectancy probably in excess of 25 years. As a matter of fact, we know of some companies who have operated on straight natural gas where their diaphragm replacement after 25 to 30 years of service is practically nonexistent and the same condition seems to exist with certain companies who are at present distributing mixtures of natural gas.

No Replacement

We do not know at this time what the eventual life expectancy of leather diaphragms is, but we feel safe to say that the probabilities are that no diaphragms operating on straight natural gas will have to be replaced during the economic life of the meters. Whether this same condition holds with regard to synthetic

diaphragms we do not know, as they have not been available for a sufficient length of time to determine the eventual results.

Regulators, either of the house type or the district governor type, are not as critically affected by a changeover to natural gas as meters. In some instances, where high concentrations of impurities have been present and where leather diaphragms have been in use, it may be necessary to replace some diaphragms, due to the hardening of the gums on the vent side of the diaphragms. It also may be necessary to inspect and replace valve discs. Most companies have experienced little trouble in their regulators when changed to natural gas.

Filtering Dust

Some companies have had trouble eventually from dust collecting in the regulators and this can be helped by using some method of allaying the dust before it starts or by using some type of filter to remove it ahead of the regulators. Unless this is done, it may be necessary to open the regulators for thorough cleaning. In some cases, district regulators have been injured by abrasion, due to the dust being carried through them at high velocity.

A change to natural gas lends itself to higher distribution pressures. Any change in pressures may necessitate the installation of individual governors if an entire pressure elevation program is contemplated or it may mean changes in existing regulators to adapt them to the higher pressures.

We believe that where regulator repairs are necessary, they should be brought to the shop for such repairs and that no attempt should be made to do the repairing in the field.

MORE ABOUT METERS

By C. W. STEWART

Research Engineer
Sprague Meter Co.

1. What effect has natural gas on meter leather diaphragms which are usually bleached and contain W.G. oil gums of liquid-phase nature?

Without doubt, all meters will be effected by the transition from "water gas" to natural gas.

First, by a stiffening of the leathers as they dry out. This condition is conducive to a fast proof trend.

Second, (in sequence) as the meters dry out, the gum formants on the valves will be progressively more adhesive with a resultant higher meter differential, conducive to accelerated bearing wear and more diaphragm distention both tending to mitigate the fast meter proof experienced in condition No. 1.

Three, should the meters remain in service through the above two cycles, the gum will wear off, with resultant lower differentials and, in my opinion, a trend toward a fast meter proof.

2. Are synthetic diaphragms suitable for natural gas?

In my opinion, based on research and field tests, synthetic diaphragms operating on clean natural gas, free of condensates, etc., will give stable meter proofs—but there is serious doubt whether they will last the longer advocated service life.

It is a matter of conjecture what will happen to synthetic diaphragms after the transition from manufactured to natural gas, due to the variable conditions apt to be encountered.

Synthetic service regulator diaphragms are in most cases far superior to leather in natural gas service.

3. What is the effect of natural gas and mixtures of natural gas and high Btu oil gas produced from No. 6 oil on meter diaphragms, governs meter accuracy and controls which have been previously using mixed coal and water gas?

I think the trend would be somewhat similar to conditions described in question Nos. 1 and 2.

4. Have companies that have changed to natural gas found synthetic meter and regulator diaphragms to be successful?

I think my answer in question No. 2 answers this, and is the general consensus of opinion.

5. What changes in meter diaphragms are needed, if any?

The service life of synthetic meter diaphragms should be substantially bettered.

Leather treatment, oils, etc. should be improved, to withstand the longer advocated service life of meters.

6. ONE STEP vs. SEVERAL STEP CHANGEOVERS

By GEORGE B. JOHNSON

Manager, Customer Service
Minneapolis Gas Co.

1. Is it better partially to change the Btu standard from 530-660, then sometime later—say five years—go to 1000-Btu with straight natural?

Whether it is better to partially change the Btu standard from 530 Btu to 660 Btu and then sometime later (five years or so) go to 1000-Btu straight natural gas is a matter of economics. If there is a large saving in production costs or if you are in need of increased distribution capacity then change over to 1000 Btu straight natural now, as you will be five years ahead in your load and revenue building plans.

If you are financially unable to make your changeover at present, then a partial changeover to 660 Btu is your next best move so as to reap what benefits you can from production savings and increased distribution capacity, that a partial change of Btu standard will give you.

2. Is there an accepted procedure for changing from carburetted water gas to natural gas through use of interim mixtures? If so, what would be the Btu values of the mixtures used?

3. Is there an interim mixture that could be used while block changeover procedure is being followed on conversion from 530 to 1000-Btu gas?

2 & 3. There is no accepted procedure for changing from carburetted water to natural gas through the use of interim mixtures. The Btu change is too great. In our last changeover from 800-Btu mixed gas to 1000-Btu straight natural gas, we used an interim mixture of 875 Btu with a great deal of success, but our 200-Btu changeover is a far cry from a 500-Btu change.

I have thought that there probably is some mixture of gases, (propane-air-natural-manufactured gas) that could be used as an interim mixture, but every mixture that I have thought of fizzles out in some part of the calculations. If the interim mixture calculates out to be all right on your present orifices and gas, it becomes troublesome after the orifice change and vice-versa.

I do not want to close the door on the possibilty of an interim mixture as there are many combinations of gases that have not been investigated and because of the recent progress in cracked propane gases, someone may some day discover a good interim gas.

For Better Gas Service: $336 MILLION

That's how much 73 major gas utilities are spending on their systems in 1950, *GAS* learned in its annual survey. In addition to the thousands of miles of line that pipeline companies will lay this year (see "Progress on the Pipeline"), distributors will construct 1938 miles of transmission carriers, 3945 miles of distribution mains. Plans of the 73 are outlined below.

Arkansas-Louisiana Gas Co., Shreveport, is spending $9,165,000. Of this, $3,343,000 is part of a two year (1949-50) $9,115,000 program, including a 20-in. line from Waskom, Texas, to Malvern, Ark., and a compressor station. These two projects account for the bulk of the $5,920,000 set aside for 1949 transmission system building (179 miles will be laid in 1950). Distribution, with 147 miles of main, will take $1,578,000 and production will use $1,667,000. Sendout will rise 115 MMcf per day in 1950. Karnack, Texas, and Jacksonville, Ark., are being added to the system.

Brooklyn Union Gas Co., getting set to receive 60 MMcf per day of natural gas at 80% load factor late this year, will increase overall capacity 68 MMcf, will lay 11 miles of natural gas transmission lines, 16 miles of distribution mains, and will spend $5,350,000, of which $3,950,000 represents unexpended balance of $4.1 million natural gas program. The other $1.4 million will be divided among transmission, $100,000; meters, mains, services, $1.2 million; works construction, $100,000. A mixed gas of 540 Btu will be served.

Central Arizona Light & Power Co., Phoenix, has put up $1,369,175 for 117.8 miles of distribution lines and other equipment.

Changeover Included

Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y., is getting its system in readiness for a changeover to natural gas with attendant thermal increase in capacity. For transmission facilities including 40 miles of 10-in., 2 miles of 8-in., $1,596,000 will be spent; for production facilities, including changeover of generators to produce 1030-Btu gas, $184,000; for distribution facilities, including 1 mile of line, $112,000; for miscellaneous, $131,200. Total outlay, $1,996,200, of which all but $46,200 will be for introduction of natural gas.

Central Illinois Light Co., Peoria. All of the company's $560,000 new construction budget is for extension of its distribution system, including 16 miles of lines.

Central Illinois Public Service Co., Springfield, is laying 19 miles of transmission line, 5 miles of distribution lines as a part of its $465,832 budget.

Central Indiana Gas Co., Muncie, is spending $1,040,000—$800,000 for distribution, $100,000 for production, $140,000 for miscellaneous.

Chattanooga (Tenn.) Gas Co. has allocated $650,000, 75% of which is for 20 miles of transmission line, with 25% for 4 miles of distribution line. Capacity will jump 20 MMcf per day. The system is converting from manufactured to natural gas.

Cheyenne (Wyo.) Light, Fuel & Power Co. will build a regulator station and will add facilities for extending service, the total costing $104,265.

Cincinnati Gas & Electric Co. and its subsidiary, Union Light, Heat & Power Co. are working on a $3.6 million budget as part of an expansion program undertaken in 1947. Transmission, with 18 miles of main, and distribution, with 5 miles, will each take $1.7 million, while production expansion will total $200,000.

Citizens Gas & Coke Utility, Indianapolis, which is waiting for FPC approval of a $1½-million, 25-mile gas line to supplement present manufactured gas facilities, has budgeted an adidtional $1,351,717 for this year. Included are $942,685 for distribution facilities and $409,032 for production. Main extension mileage totals 43.

City of Corpus Christi, Texas, will lay 24 miles of mains costing $224,000.

City Public Service Board, San Antonio, Texas, winding up its fiscal year Aug. 1, will have spent $1,446,200 for distribution extensions, including 65 miles of main. Output will be boosted 30 MMcf per day.

Coast Counties Gas & Electric Co., San Francisco, is spending $1,471,200. Services will cost $330,000; mains, $580,000; meters and regulators, $148,400; with the remainder going for tools, land and buildings, and miscellaneous. Mains being laid stretch 72 miles; 4638 new and replacement services will use 63 miles of pipe.

Columbia Gas System Inc., New York, has budgeted $31,740,000. This is part of a five-year, $178 million program. Production will use $9,389,000; transmission, $12,903,000; distribution, $7,555,000; and other, $1,893,000.

Connecticut Light & Power Co., Waterbury, has programmed expenditures totalling $1,132,900, of which $618,900 is for distribution, $263,000 for plant, $193,000 for mains, meters, services. Miles of mains to be laid—9.

Consolidated Gas Electric Light & Power Co. of Baltimore (Md.) will start its conversion to natural gas this month. The job will take five months. Straight natural gas will be served, with manufactured gas of 1050 Btu being used for peaks. Present manufactured gas facilities are being converted to produce the high-Btu gas. Allocations of $3.4 million, as part of the 1949-1953 $18.1 million program, are split between production, $1 million, and distribution, $2.4 million. Twenty to 25 miles of main will be laid.

Consumers Gas Co., Reading, Pa., is spending $818,000 as part of a $13,580,000 program running from 1948 to 1954. Mains are allocated $585,000; distribution, $64,000; production, $169,000. Manufactured gas capacity will increase 3 MMcf per day for firm use, 6 MMcf per day for peaks. Included in construction is a 21-mile natural gas lateral.

Consumers Power Co., Jackson, Mich., has a program for increasing peak sendout by 50 MMcf per day which is costing $6 million. Distribution, including 300 miles of mains, will take $4.5 million; 100 miles of transmission lines and equipment will take $1.5 million.

Delaware Power & Light Co., Wilmington, is spending $700,000: for distribution, 65%; for transmission (including 10 miles of line), 30%; for production and standby, 5%. Send-out will be increased 10 MMcf per day of mixed gas.

Department of Public Utilities, Colorado Springs, Colo., in expanding its distribution system, wil spend $245,000.

The East Ohio Gas Co., Cleveland, is concentrating 1950 construction on distribution. About 250 miles of main will be laid, and in is $5.5 million budget, $4 million is tagged for this phase of operations. Production will take $200,000; storage, $750,000; transmission, $100,000; general, $450,000.

Equitable Gas Co., Pittsburgh, to extend facilities to accommodate continued development and growth of househeating load, will spend $3,177,105. Included are 9 miles of mains, a 3200-hp compressor station. For firm service, 30 MMcf per day additional sendout will be provided; for peaks, 60 MMcf.

Gulf States Utilities Co., Baton Rouge, La., will lay 40 miles of main as part of its $417,-500 distribution system construction plan.

Hartford (Conn.) Gas Co. is spending $500,000—$310,000 for new business, $100,-000 for transmission, $80,000 for transportation and miscellaneous, $10,000 for production. New transmission lines total 3 miles, distribution 12 miles.

Houston Natural Gas Corp. is spending $2.8 million, mostly for distribution facilities involving 225 miles of line.

Indiana Gas & Water Co. Inc., Indianapolis, is spending $1,632,000. Of this, $760,000 is part of a long-range expansion program, started in 1946, to be completed in 1951, costing $3,670,000. For transmission, $556,000 will be spent, including 30 miles of line; for distribution, $828,000, including 36 miles; for building and equipment, $209,000; for production, $39,000. Service is being extended to Arcadia, Ind. Aurora, Ind., with 600 customers, will convert from 750-Btu butane air to natural gas. An extra 53 MMcf is being made available.

Interstate Power Co., Dubuque, Iowa, is using most of its $56,800 budget for distribution system improvements, including 3½ miles of mains.

Iowa Electric Light & Power Co., Cedar Rapids, is spending $381,855. Marshalltown is being converted to natural gas, and natural gas service is being extended to Colo and State Center. For converting appliances in Marshalltown, $200,000 is allocated; for distribution lines and other equipment, $181,-855. Sendout will increase 3951 Mcf per day.

Iowa-Illinois Gas & Electric Co., Davenport, Iowa, will increase capacity by 5 MMcf per day. Distribution system extensions will cost $1,750,000.

Iowa Power & Light Co., Des Moines, will lay 25 miles of distribution lines, total system extensions costing $1 million. Output of natural gas will be upped 20 MMcf per day.

Jersey Central Power & Light Co., Long Branch, as part of a $5,225,000 program started in 1948 and continuing until 1952, has set up for 1950 $2,037,793 including $160,227 for production, $384,500 for distribution, $1,427,886 for transmission, $65,-200 for transportation and communications. Firm service will be increased 7750 Mcf per day, peak loads 24,000 Mcf, and 69 miles of line will be laid; 20,200 customers will be converted to natural gas. The entire output increase will be for natural gas distribution.

Kings County Lighting Co., Brooklyn, is using about half its $500,000 construction budget to convert a water gas plant for the use of natural gas. Most of the remaining half will go into construction of a transmission line for taking natural gas.

Laclede Gas Co., St. Louis, changed over to natural gas last year, and is receiving 200 MMcf per day. For 1950, the first year of a four-year $20 million program, $8 million will be spent to extend and strengthen the distribution system. Main extensions of 370 miles are planned.

Lone Star Gas Co. and Lone Star Producing Co., Dallas, is laying 380 miles of transmission and gathering lines, 450 miles of distribution lines, and upping sendout 75 MMcf per day, at a cost of $6,694,400 for distribution, $4,402,100 for transmission, and $6,-191,000 for production. Total for 1950, $17,-287,500.

$10 Million

Long Island Lighting Co., Mineola, N. Y., has a whopping $10 million budget. With natural gas expected to arrive before 1951, most of the money will be used in connection with reforming it in a new three-unit catalytic cracking plant as well as its transmission, storage, and distribution. It's all part of a $12.5 million project started in 1949, to be completed in 1952. Production facilities will cost, in 1950, $5 million; storage, including a 5-MMcf holder, $430,000; transmission, with 20 miles of line, $2,935,000; distribution involving 60 miles of mains, $1,610,000; and general, $25,000. Output for presently served areas will jump 65 MMcf per day.

Louisiana Power & Light Co., New Orleans, is spending $717,000 for distribution system extension, including 50 miles of pipe.

Lowell (Mass.) Gas Co., changing over to 660-Btu oil gas, has budgeted $450,000 for 1950, including $350,000 for production, $75,000 for distribution. This is part of 1946-50's $1,250,000 program.

Lynn (Mass.) Gas & Electric Co., changing to 1000-Btu oil gas, by October 1950 will have added 3.7 MMcf per day firm, 7 MMcf per day for peaks. As part of its 1947-1951 $2.3 million expansion program Lynn will spend $1,790,000 this year—$1,680,000 for production; $100,000 for distribution.

Madison (Wis.) Gas & Electric Co., which completed changeover to natural gas during January, has allocated $402,513 for improvement of gas facilities, including $349,259 for distribution lines. Mileage totals 9½. The remainder is for general plant and production.

Minneapolis Gas Co. is laying 100 miles of distribution lines, 4 miles of transmission lines; is spending $4 million of which 80% is for distribution, and will increase firm capacity 27 MMcf per day. For peak loads, 12 MMcf of LP-Gas will also be available.

Montana-Dakota Utilities Co., Minneapolis, is allocating its entire $11-million budget to a 340-mile transmission line running from Worland, Wyo., to Baker, Mont. Also included is a compressor and dehydration plant at Worland. Capacity will be boosted 20 MMcf.

Nashville (Tenn.) Gas & Heating Co. has earmarked $688,000 this year to carry on the expansion program initiated with the introduction of matural gas in 1946. About $650,-000 will be for distribution purposes, including 25 miles of mains.

New Orleans Public Service Inc. has budgeted $2,013,772, of which $1,897,816 is for distribution, including 40 miles of pipe; $83,-046 for general plant; $32,892 for miscellaneous.

New York State Electric & Gas Corp., Ithaca, is allowing $1 million for expansion —$250,000 for 8 miles of medium-pressure transmission, $750,000 for 15 miles of distribution. This is a continuation of expansion brought on by new house heating customers, which has cost $5 million since 1946, will cost a million a year as long as present rate of load growth continues. A boost of 7 MMcf per day in next winter's peak loads will be made possible.

North Penn Gas Co., Port Allegany, Pa., is spending $71,704. Distribution and transmission extensions and replacements will aggregate seven miles. Services and meters will cost $15,943; $26,578 will go for distribution lines and equipment; $11,000 is allotted for field operations; the remainder is for tools and equipment. Firm natural gas capacity will be upped 200 Mcf per day; peak load capacity will rise 1 MMcf.

North Shore Gas Co., Waukegan, Ill., is spending $450,000—$175,000 for a distribution building; $245,000 for the distribution system; $30,000 for production. Included are 16 miles of mains, two propane tanks.

Northern Oklahoma Gas Co., Ponca City, has allotted $400,000 for this year's portion of a two-year, $1 million expansion started in

1949. Transmission facilities, including 25 miles of line, will take $325,000 of this; distribution facilities will consume the remainder.

Northern States Power Co., Minneapolis, and subsidiaries, will spend $1,165,038, of which $1,006,598 will be spent in Minnesota, the remainder in Wisconsin. Production will take $210,680; distribution, chiefly to meet a big heating load in St. Paul, $954,358. Red Wing, Minn., will be changed over from coal gas to propane-air.

Oklahoma Natural Gas Co., Tulsa, has set aside $7,038,600 for 1950. For production and underground storage, $1,217,700 is scheduled to be spent; for transmission, $2,250,500; for distribution, $2,887,800; for general improvements, $682,600. Seven miles of transmission line, 33 miles of distribution will be added.

Pacific Gas & Electric Co., San Francisco, has budgeted $52 million for 1950, chiefly for its "Super Inch" line. This is part of a 1948-1952 plan costing $116 million. Production expansion will cost $500,000; transmission, $34.5 million; distribution, $17 million. Included are a 17-MMcf holder, a 6-MMcf holder, and two 3-MMcf holders. Miles of transmission line will total 480, of distribution lines 650. Capacity by 1952 will rise 250 MMcf per day—all natural.

Peoples Water & Gas Co., Miami Beach, Fla., will use part of its $371,500 construction budget to increase peak sendout 8.5 MMcf per day. Production will cost $51,500 for condenser, propane storage, and housing; transmission, two compressors and auxiliaries, $159,300; distribution, $127,500; general, $33,200. Four miles of distribution lines will be laid. The outlay is part of a general construction plan started in 1945.

Philadelphia Electric Co.'s gas department will spend $4,617,500 as part of a long-range, $36,886,000 program extending from 1947 through 1955. With costs allocated to production, $1,490,000; transmission, $1,390,000; and distribution, $1,737,500, nine miles of transmission main and 35 miles of distribution mains will be laid, and output of 520-Btu gas will be increased 16,559,426 Mcf per year.

The Philadelphia Gas Works Co., which launched a $54-million program in 1940 to be completed in 1954, is allocating $4,510,000 for this year. Production outlay will total $1,353,000; distribution and transmission, $3,157,000. For firm service, 30 MMcf of natural gas will be added to output; for peaks, 20 MMcf of LP-Gas will be available. Pipeline construction calls for 48 miles of new line, 8½ miles of replacement. The company is changing over from 530 to 650 Btu.

Pittsburgh Group, Columbia Gas System is spending $9,623,000, almost all of which is for production, storage, compression, or transmission of natural gas.

Portland (Ore.) Gas & Coke Co. has set aside $407,220—$112,720 for production, $263,500 for distribution, $31,000 for general expenses. Five miles of distribution lines will be laid.

Public Service Co. of Colorado (Denver) and Subsidiaries. Approximately $6 million to be spent will include 150 miles of distribution mains, 35 miles of transmission lines, and will increase output by 30 MMcf per day about Oct. 1.

Public Service Electric & Gas Co., Newark, N. J., is spending $15.9 million. Distribution outlay will total $8.6 million; production, $6.4 million; general, $900,000. Main mileage will be increased 130 miles. Equipment and piping for utilizing natural gas in six water gas manufacturing plants, installation of naphthalene scrubbing equipment, gas scrubbing and conditioning equipment for the Camden coke plant are big production items. Transcontinental Gas Pipe Line Corp's Texas-New York line will bring 700,000 therms per day of natural gas, resulting in a net increase in plant capacity of 87 MMcf of 525-Btu gas per day, although this may not occur this year. The natural gas would be used for cold enrichment and reforming at five existing water gas plants. A sixth plant has been receiving natural gas since a year ago.

Output Up 6 MMcf

Rochester (N.Y.) Gas & Electric Corp., with $2,925,340 set aside for construction, is converting service of 11,000 (about 10%) of its customers to straight natural gas. This is part of 1947-51's $11.9 million program. Production will use $674,847; distribution, $1,748,493; meters and regulators, $230,000; service installation, $250,000; tools, etc., $22,000. Thirty-five miles of mains will be laid; output will increase 6 MMcf per day.

San Diego Gas & Electric Co. is spending $1,796,000, including $3000 for production, $35,000 for transmission, $1,758,000 for distribution. The latter will involve 60 miles of mains. Bostonia and the South Bay area are new areas to be served.

Seattle Gas Co.'s plans for spending $260,000 include $137,000 allotment for distribution facilities and $123,000 for production.

South Carolina Electric & Gas Co., Columbian, changing over 540-Btu carburetted water gas to 950-Btu oil gas, is spending $360,465 this year. Production will take $222,952; distribution, $137,513; distribution line extensions will run to 15 miles of 3-in. equivalent; output will rise 3.8 MMcf.

South Carolina Power Co., Charleston, is laying 1 mile of transmission line, 6 miles of distribution line, spending $168,189 for 1950, including $67,670 for production, $85,563 for distribution, $7748 for transmission, $7208 for other expenses. An added 425 Mcf will be made available for peaks.

South Atlantic Gas Co., Savannah, Ga., lists $255,000 worth of construction items, divided as follows: distribution, $125,000; LP-Gas production, $73,000; production, $49,000; other, $8000.

Southern Indiana Gas & Electric Co., Evansville, has budgeted $296,425 for 1950, including $2500 for manufacturing plants, $282,800 for new business extensions, mains, meters, etc.; and $11,125 for general plant—tools, etc. About 4½ miles of main are included.

Southern Union Gas Co., Dallas, will put up $5.5 million for system extensions to add Espanola, Riverside, Santa Cruz, and Cuba, N. Mex., to its list of towns served. Transmission —70 miles of lines—will cost 2.1 million; distribution—75 miles—$2.2 million; production—with 10 miles of gathering lines—$700,000; miscellaneous, $500,000. Present customers will also benefit. Capacity will increase 15 MMcf.

Southwestern Public Service Co., Amarillo, Texas, will lay 24 miles of distribution lines to expand its service. Total outlay is $384,842.

Tampa (Fla.) Gas Co. is allocating $75,000 for this year's portion of a long-range half-million-dollar plan. Meters and mains added will cost $45,000, plant $3000. Capacity will be increased 1 MMcf per day.

United Fuel Gas Co., Charleston, W. Va., is using the bulk of its $9,755,300 budget for production of natural gas. A total of $6,699,500 is earmarked for well drilling, storage pools, etc. Well and field lines to be laid total 57 miles, distribution mains, 85 miles. For transmission, $1,191,300 will be spent; for distribution, $1,548,900.

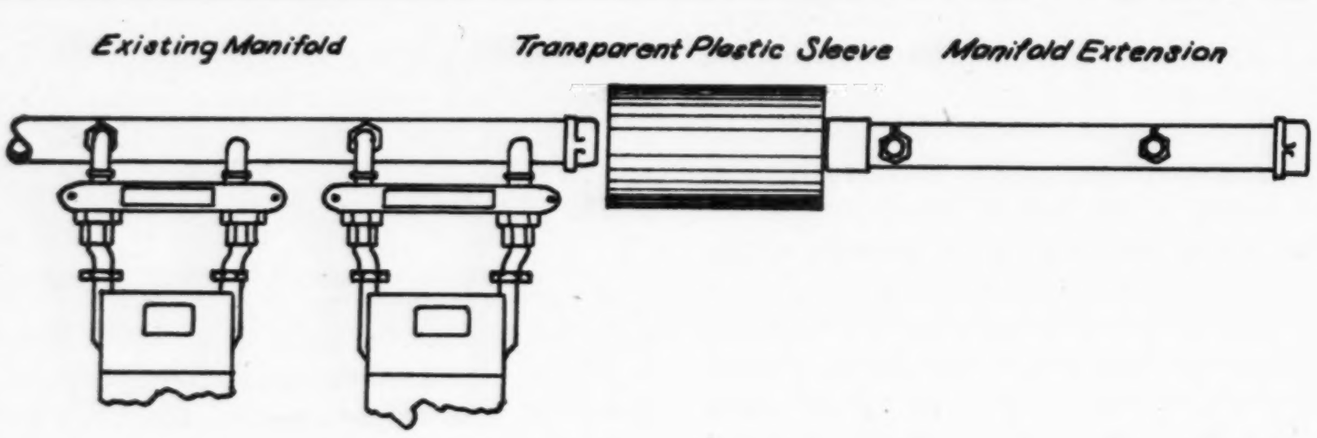
Washington Gas & Electric Co., Tacoma, is spending $55,218 for distribution facilities.

Washington (D.C.) Gas Light Co. and Subsidiaries are spending $5.5 million including $1.5 million for transmission, $3,575,000 for production, and $425,000 for general plant. Mileage of transmission lines being laid is 20; of distribution, 60. The company expects to start receiving an extra 100 MMcf per day of natural gas this year.

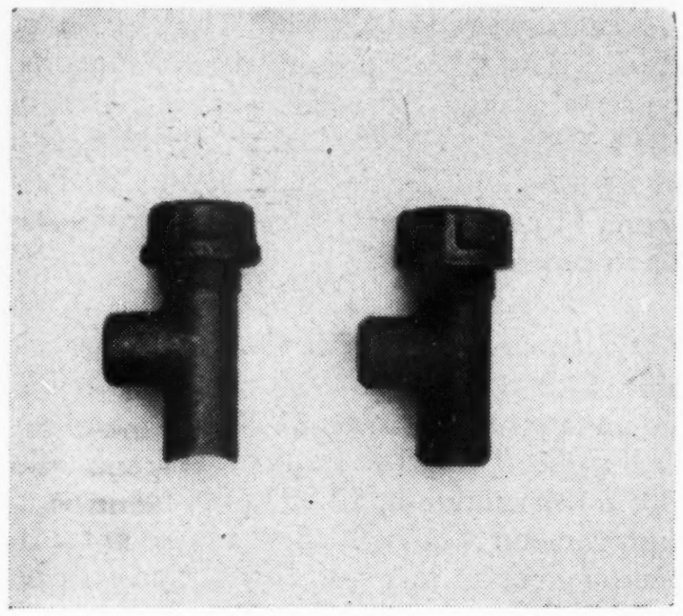
Wisconsin Power & Light Co., Madison, has allotted $395,373 for gas facilities. Of this, transmission construction will take $167,846; distribution, $144,953; general, $27,224; and production and storage, $55,350.

Worcester (Mass.) Gas Light Co., which changed in 1949 to 660-Btu carburetted water gas, will increase capacity by 2.4 MMcf per day in 1950. The $931,000 the company will spend is part of a $4.6 million budget set up for 1946 to 1952. Production will take $231,000, distribution and transmission, including 7 miles and 4 miles respectively, $700,000.

OPERATING IDEAS AND EQUIPMENT

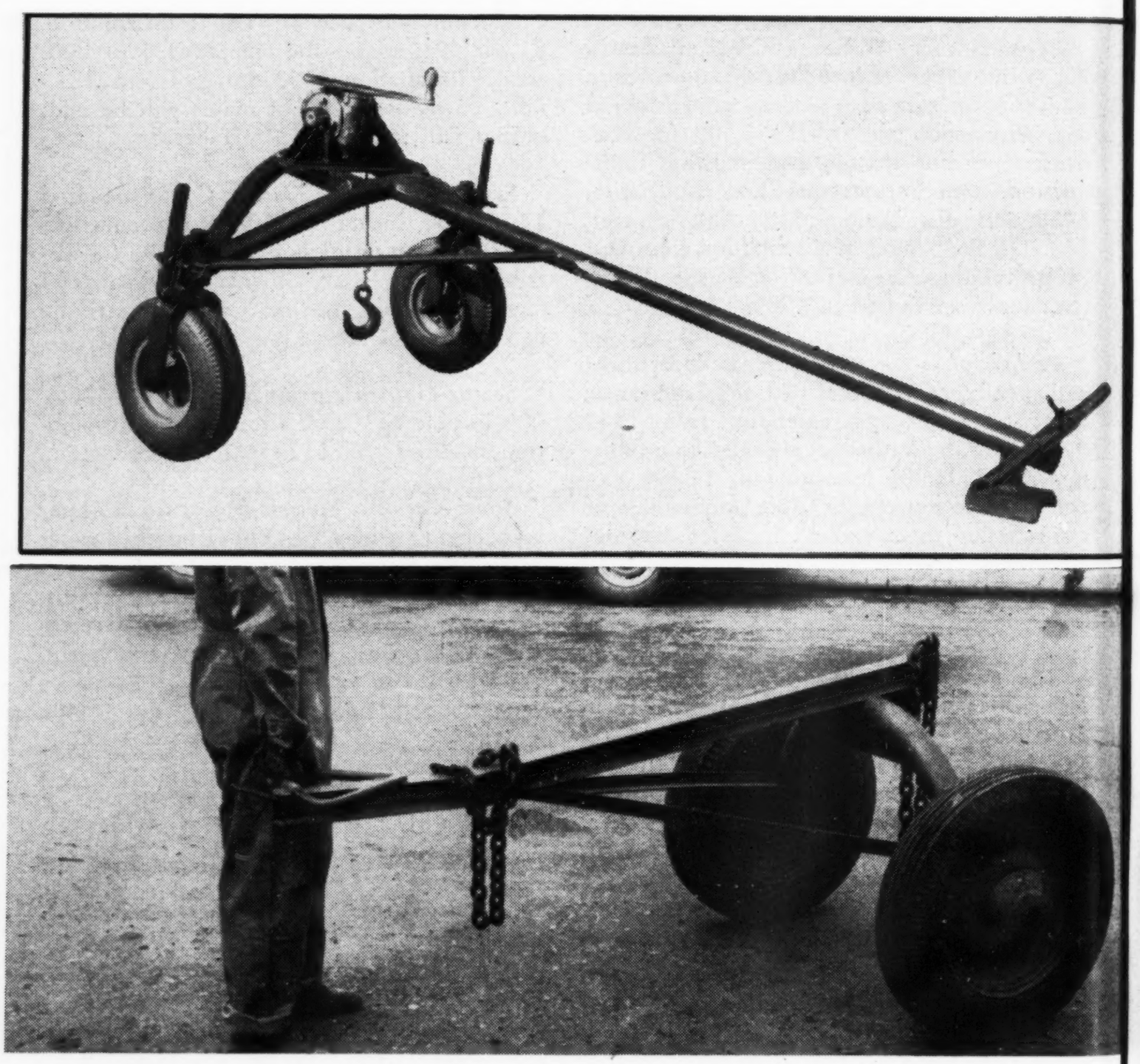


Additional meter outlet on an existing manifold is provided by Southern California Gas Co. with the method illustrated. It has proved its worth by making it unnecessary to interrupt service to customers and by reducing man hours on the job. Recommended procedure is to (1) loosen cap on end of existing manifold, (2) slip plastic sleeve over cap and tape to manifold, (3) insert manifold extension inside open end of sleeve and tape sleeve to manifold extension, (4) slowly remove cap with fingers, (5) start coupling threads and make up hand tight, and (6) remove sleeve and make up coupling with wrench. An alternative procedure involves the use of right and left coupling instead of line coupling, or use of plastic bag and a closed service cock.

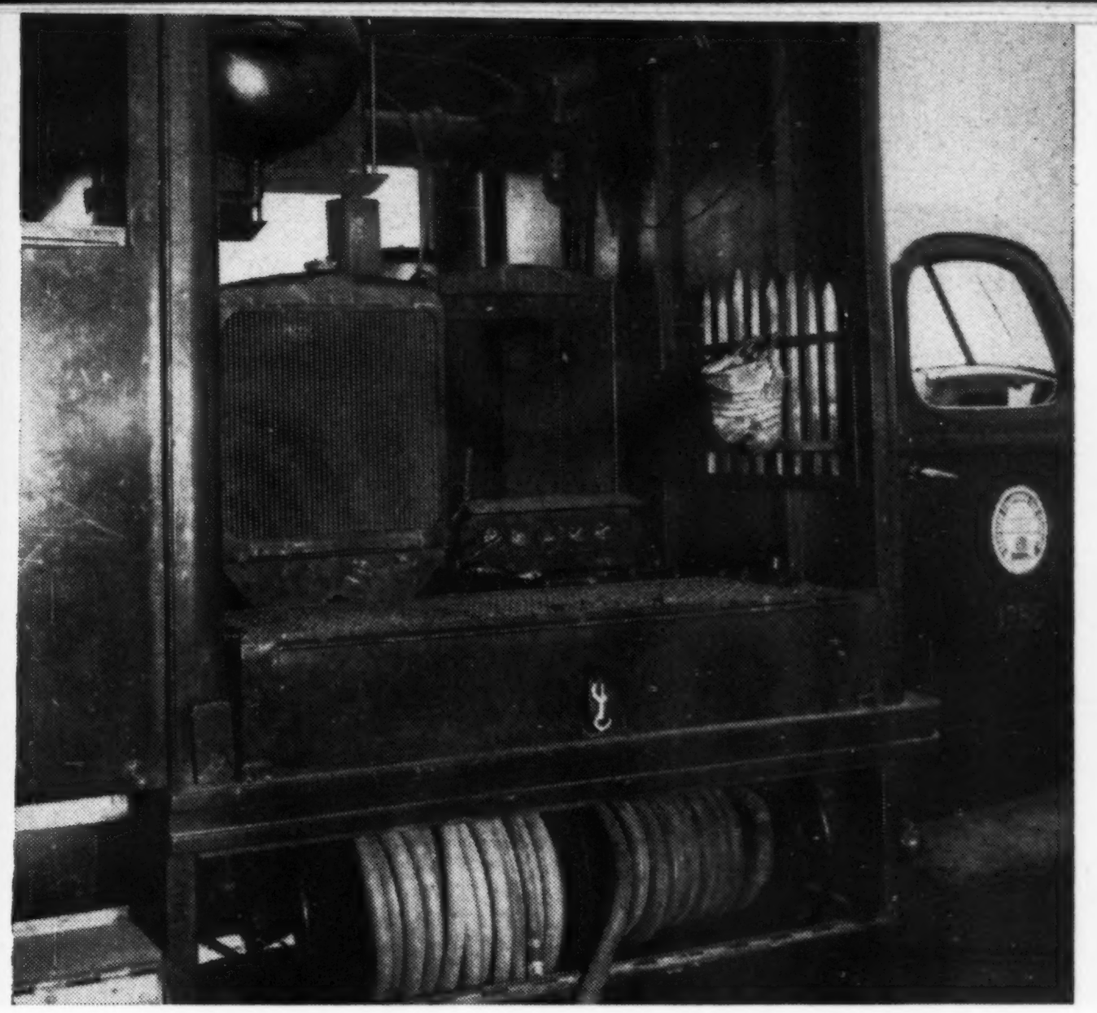


Weld-type service tee for making service connections to mains has been adopted by Southern California Gas Co., and is shown at left in the photo (the old type is at right). By elimination of the bevel or the inlet end, fabrication cost is reduced. Tests disclosed that the bevel was not necessary to insure sufficient penetration and a satisfactory joint. The contour shape of the inlet eliminates a large percentage of field shaping, which more than offsets the additional fabrication cost.

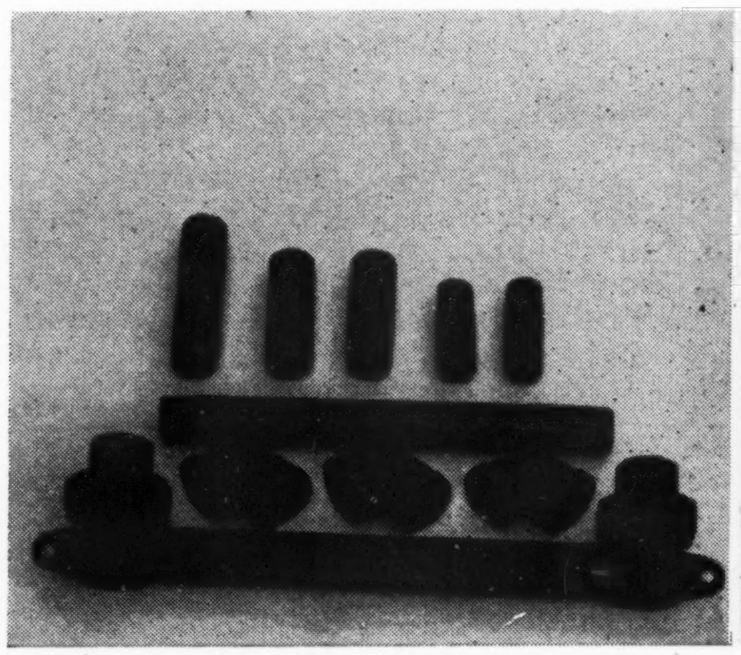
Plugging unit used by Houston Natural Gas Co. for intermediate and high-pressure lines (above). A special rubber plug is inserted through a stop-cock core of any standard size. It is used to replace damaged or broken stop cocks on loaded lines without shutting off the gas. It is particularly useful on service risers. Bottom photo shows it as inserted through the stop cock into the nipple, to simulate the riser, and expanded. (From Second Southern Gas Assn. Wrinkle Film.)



Pipe dolly—increased maneuverability is only one of the advantages of this new pipe dolly (top) over the old one Southern California Gas Co. formerly used. It has castor wheels which can be positioned parallel or at right angles to the tongue; it has a built-in hoist (a war surplus bomb hoist), and the improved load distribution is an important safety factor, as injuries caused by the tongue flying up and striking the workman or catapulting him over the unit are virtually eliminated. It is used for maneuvering main pipe into position for lowering. Photo shows old dollies at bottom.

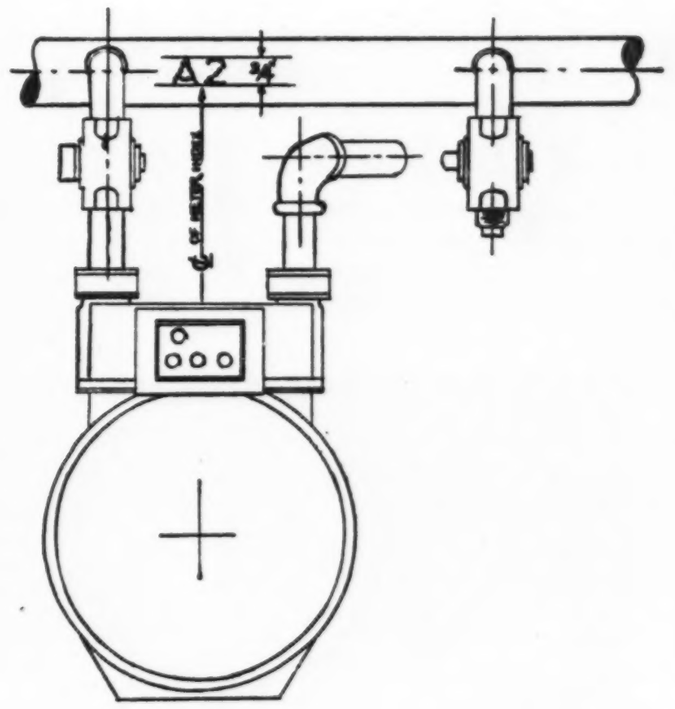


Mounting compressors on heavy duty service trucks by this new method (left) is proving advantageous for Southern California Gas Co., Los Angeles. It is compact, saving valuable bed space; provides convenient location for operating gauges and controls; makes all servicing points readily accessible; and, in the event of a major overhaul, permits installation of spare or exchange units in a minimum amount of time. Photo shows old method at right.



Packaged meter set—when installing single domestic meter assemblies, Southern California Gas Co. saves time in the preparation and processing of necessary paper work both in the field and in the storeroom with its packaged meter set assemblies. The packaged method also simplifies and speeds up the work of the company's night loading crews. Only a single entry is required on the stores requisition as against five when non-packaged assemblies were used.

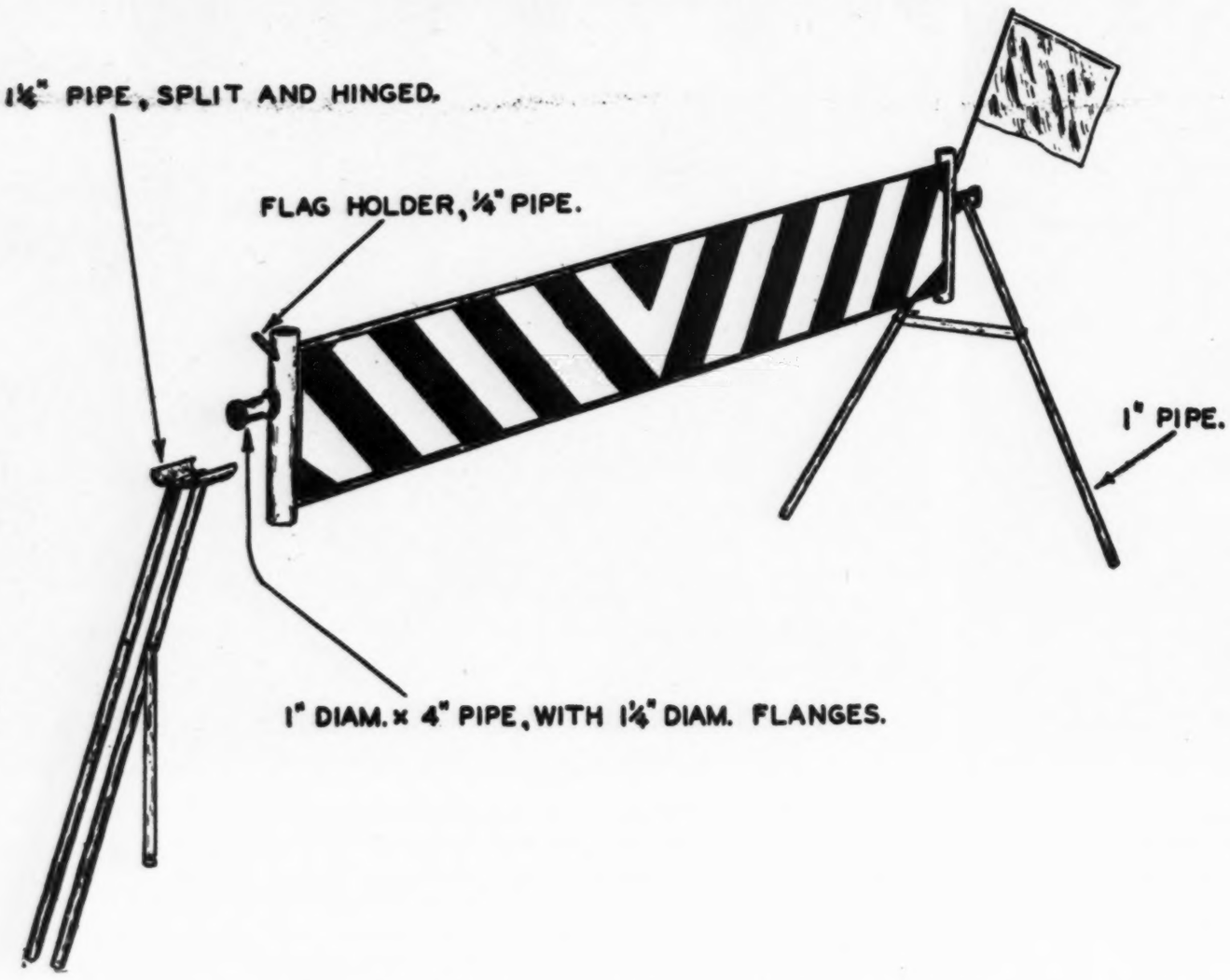
Writing desk and forms compartment built into the company's trucks, provides three-fold advantages for Southern California Gas Co. operations. All forms are readily and conveniently available; the entire operation of writing forms and reports in the field is protected from the weather; and a flat, stable writing surface is provided, resulting in more legible forms and reports. This device is useful on any truck used in an operation where forms must be prepared in the field.



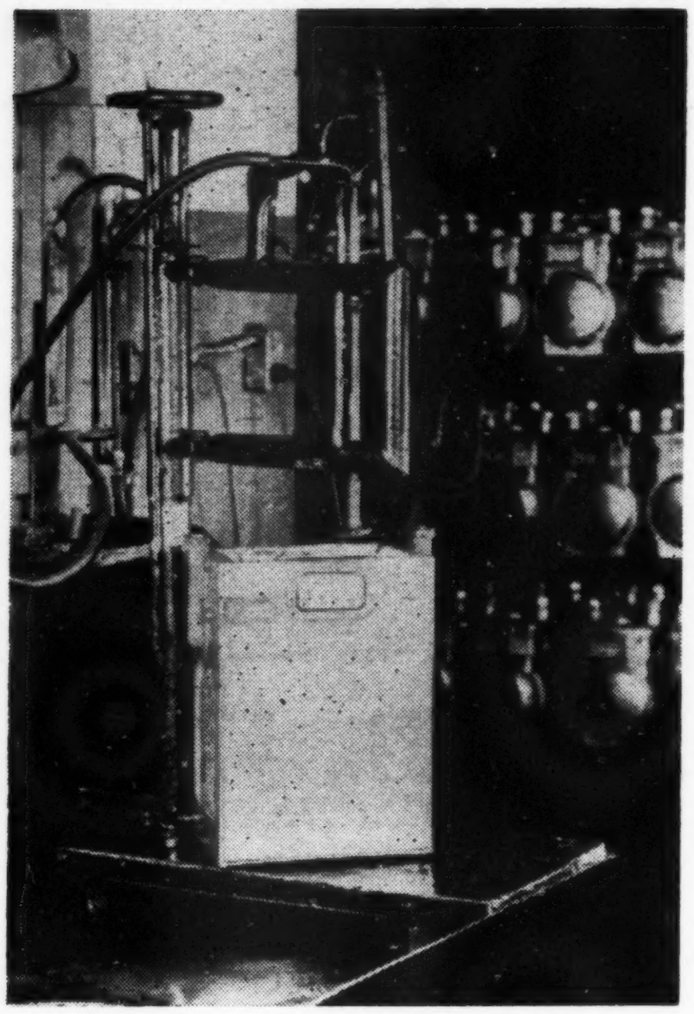
Meter manifold badging—this method of identifying premises served by meters installed on meter manifolds was devised by E. E. Yockey, meter repair foreman for Coast Counties Gas & Electric Co., Santa Cruz, Calif. The identity is marked on the manifold to the right of the spud to which the meter is connected, and centered above the center of the meter index, as shown in the sketch.

To mark the manifold, identifying letters or numerals are first drawn in pencil, after which punch marks are made sufficiently deep to retain their legibility after the manifold has been painted. Letters are in standard capitals, and numerals and letters are ¾-in. in height. Where house numbers are in use, they are used for identification. When not, descriptions are used in combinations of the following letters: F for front, B for back, T for upstairs (top), D for downstairs, C for center, R for right, L for left, A for apartment (prefix when necessary), O for office (prefix when necessary). Thus, upstairs front is TF, Apartment C is AC, etc. Right or left is determined by position as viewed from the street.

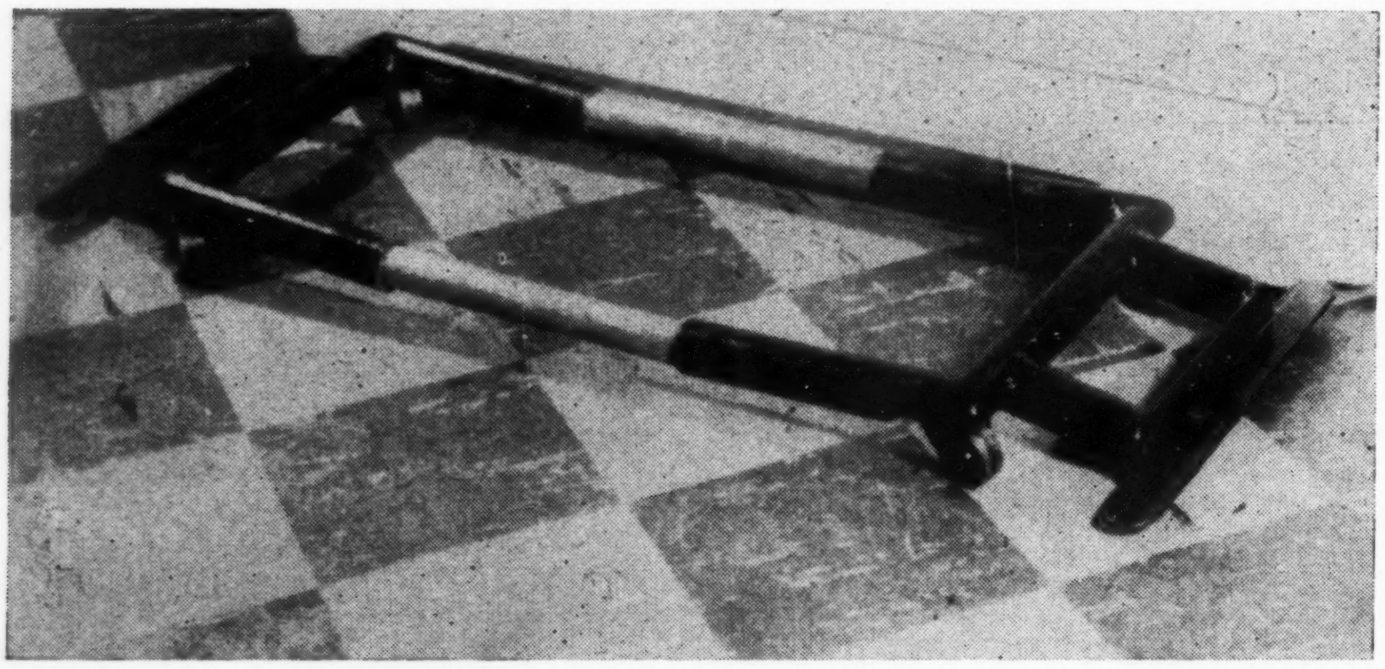
Manifolds are marked at the time each meter is set, or if identification is impossible at that time, by the serviceman making the first turn-on.



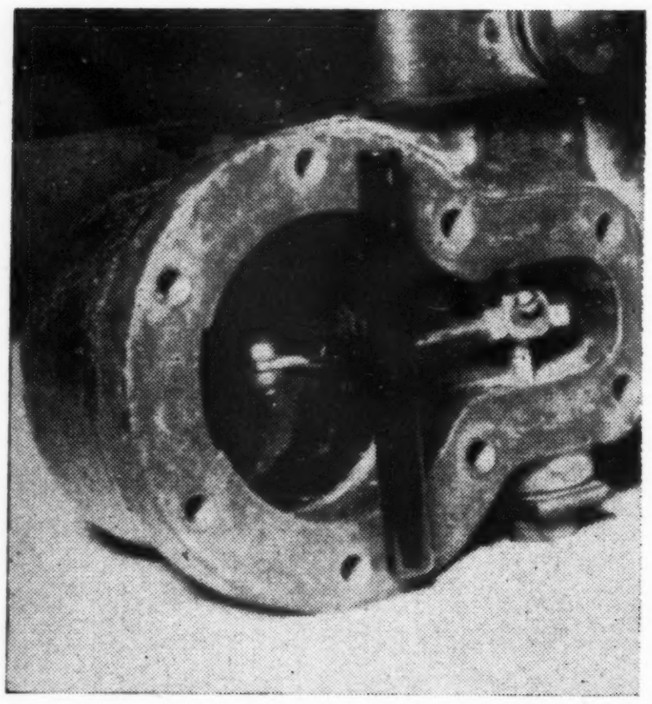
Barricade which will stand up in strong wind or normal accidental bumping and is designed for compact storage is shown above. The principle which prevents overturning by a gust of wind is based on free pivoting of the barricade sign. The sign returns to a vertical position as the wind lessens. As shown, the legs are hinged and, when opened, the upper ends form cradles or bearings which support 1-inch nipples extending from the ends of the sign. For stowing, the sign breaks down into three compact units. Henry M. Smith, Coast Counties Gas & Electric Co., Concord, Calif., designed the barricade.



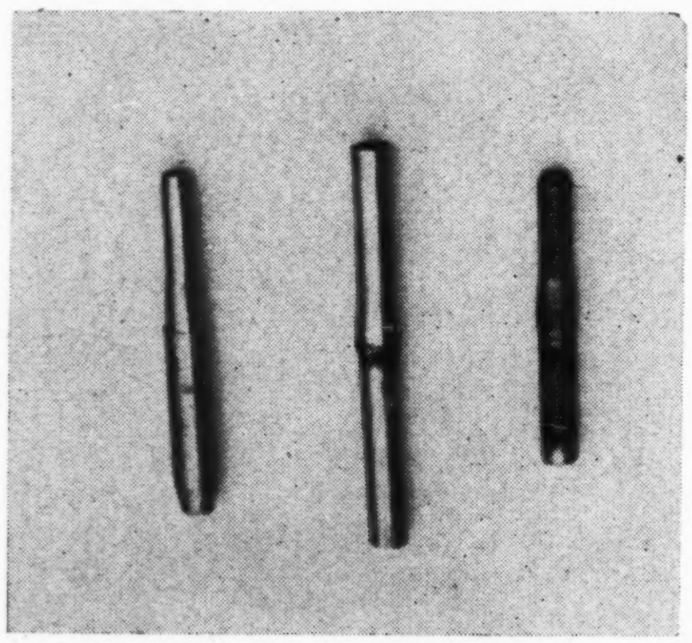
Diaphragm testing apparatus is used by Oklahoma Natural Gas Co., Tulsa, It holds a slight air pressure in the diaphragm chamber for a short period, and any decrease in pressure is noted by a manometer. Air from a low-pressure source passes through an inlet nozzle clamped over the diaphragm port and sealed by a rubber gasket. The manometer is connected between the nozzle and the air inlet valve. Air valve is opened until 4 in. of pressure shows on the manometer. Supply air is then shut off and the operator checks for leaks. A screw device is used to adjust the apparatus for various sizes of meters. Photo shows nozzle ready to be clamped in place. (From Second Southern Gas Assn. Wrinkle Film.)



Dolly, used by Oklahoma Natural Gas Co., Tulsa, is used for moving ranges to and from—and around—the sales floor. So constructed that it is hidden by the range, it need not be removed while the range is on the floor. Two extension sleeves, one in each longitudinal frame, permit expansion of the dolly to fit various sizes of ranges. Wheels are made of hard rubber or some other substance that will not mar the sales floor. (From Second Southern Gas Assn. Wrinkle Film.)



T-tool—for tightening and adjusting nuts on orifice meter float levers, Oklahoma Natural Gas Co., Tulsa, uses this T-tool with slotted end. With this device, operator can hold the float in the exact center of the float chamber and keep the float lever perpendicular to the float while adjusting the float lever nuts. Photo shows tool in place. (From Second Southern Gas Assn. Wrinkle Film.)



Belling tool for field fabrication of bell-and-spigot type joints in copper mains and services, has been devised by Southern California Gas Co. Easily removed after the bell is completed (a sharp blow after the tubing is against the shoulder will cause the tool to bounce free), it has longer life because of its tapered striking head and the tougher material of which it is made. The shoulder conveniently and accurately controls the depth of the joint. In the photo, the completed tubing joint is shown in the center, with the old style belling joint at right and the new style jaw at left.

Fig. 1. Model 26-102 Titrilog.

THE TITRILOG

And its application to continuous measurement of sulfur concentration in gas streams. Part I of two parts.

By ROBERT R. AUSTIN, L. EARL PERCY, and EDWARD E. ESCHER

THE measurement and control of sulfur content of gas streams has long been a problem to most branches of the gas industry. The development of a continuous recording instrument for sulfur concentration measurement marks a forward step in instrumentation in this industry. The presentation of a paper describing the Titrilog and discussing its applications to some typical problems was greeted with interest in the 1949 production and chemical conference of the American Gas Assn.[1]

Exclusive

Wider field experience in operation on various problems now makes it possible to determine more fully the value of this analytical tool to the engineer in his study and control of sulfur where it is a matter of concern in purchase and sale of field gas, in blending operations, in the treating of high sulfur gases, in distribution of gas where corrosion of lines and appliances may occur, and in gas odorization.

The Titrilog measures the concentration of reactive sulfur compounds by continuous titration with bromine. The titration end point is determined by a potentiometric method, and the voltage so derived is applied to the control of the titration. The bromine is produced by electrolysis. A permanent record of the electrolysis current which is a measure of sulfur concentration, is made by a strip chart recorder.

The Titrilog is shown in *Fig. 1*.

It is the purpose of this paper to discuss the principle of operation of the Titrilog, its design features, performance characteristics and its use in practical applications under various field conditions.

DEVELOPMENT AND DESIGN

The development program of the Consolidated Engineering Corp., which led to the production of the Titrilog as a commercial instrument was begun with the support of the Army Chemical Corp. The work was at that time directed toward the production of an instrument capable of continuously measuring the concentration of mustard gas in contaminated air. Extreme sensitivity, as well as automatic operation, was required. These objectives have been achieved by the application of a new principle to titration reactions, that is, the electronic control of reagent generating current.[2]

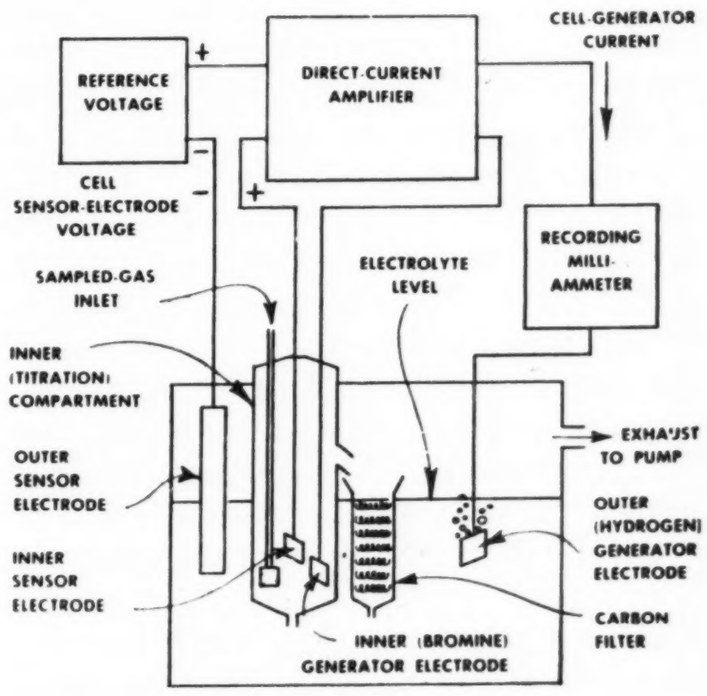


Fig 2. Titrilog cell and amplifier block design.

Principle of Operation

This principle may be explained by reference to *Fig. 2*, where the essential components of a titrating instrument are shown in a schematic diagram. Bromine generating current for the titration is supplied by the "direct-current amplifier" shown at top center, and passes through the recording milliameter. The current passes through the electrolyte of the cell where, by electrolysis, hydrogen is produced in the outer cell and is wasted and bromine is produced at the generating electrode in the inner titration cell.

Near this electrode is a second electrode which is called a sensor, because of its sensitivity to change in bromine concentration. The voltage developed between it and a stable electrode in the outer cell is responsive to the bromine concentration in the inner cell. It will be seen that the voltage of this sensor system is applied to the input of the amplifier. In this input circuit is an adjustable reference voltage opposing the sensor voltage. It is readily seen that this reference voltage may be set equal to the sensor voltage existing at a given bromine concentration in the titration cell, and that the input circuit can be so arranged that when the cell sensor-voltage falls below the set reference voltage, the amplifier output current will generate bromine.

Operation of the instrument may now

[1] "The Automatic Recording Titrator and its Application to the Continuous Measurement of the Concentration of Organic Sulfur in Gas Streams." Robert R. Austin, Ph.D., Consolidated Engineering Corp. Presented before the Production and Chemical Conference of Technical Section of AGA, May 1949.

[2] "Instrument for Automatic Titration," *Anal. Chem.*, *20*, 1008, 1948.

Dr. Austin is chief chemist, Consolidated Engineering Corp., Pasadena, Calif. Mr. Percy and Mr. Escher are chemists on his staff.

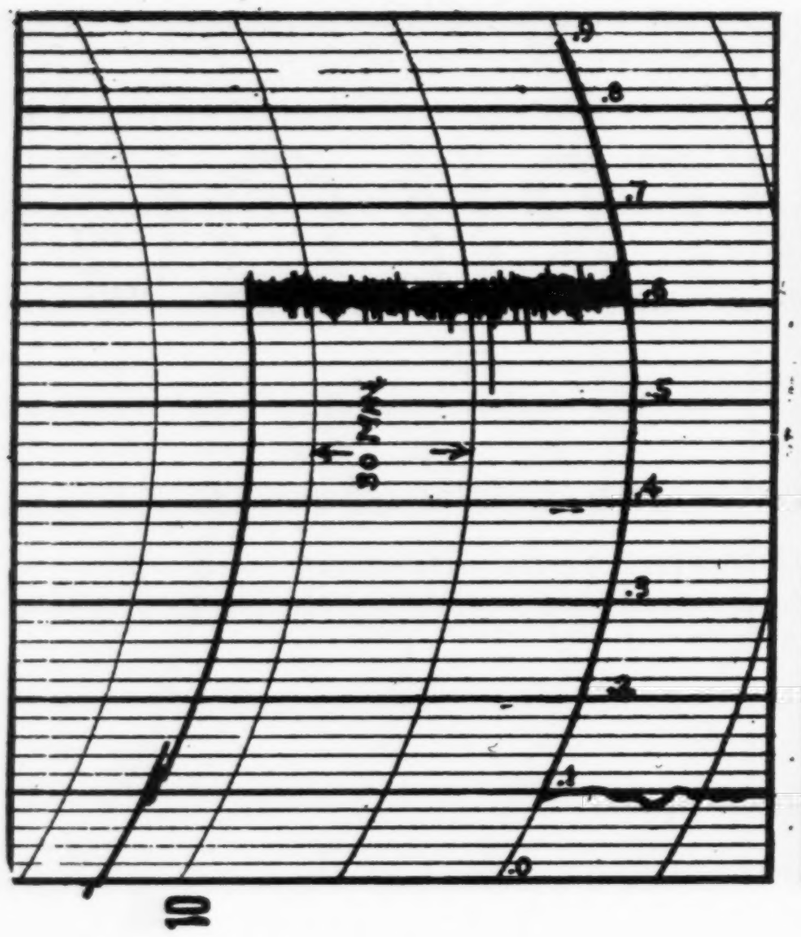


Fig. 3. Titrilog Record. Zero level, .1 m.a. Total sulfur, .6 grains/ 100 cu ft.

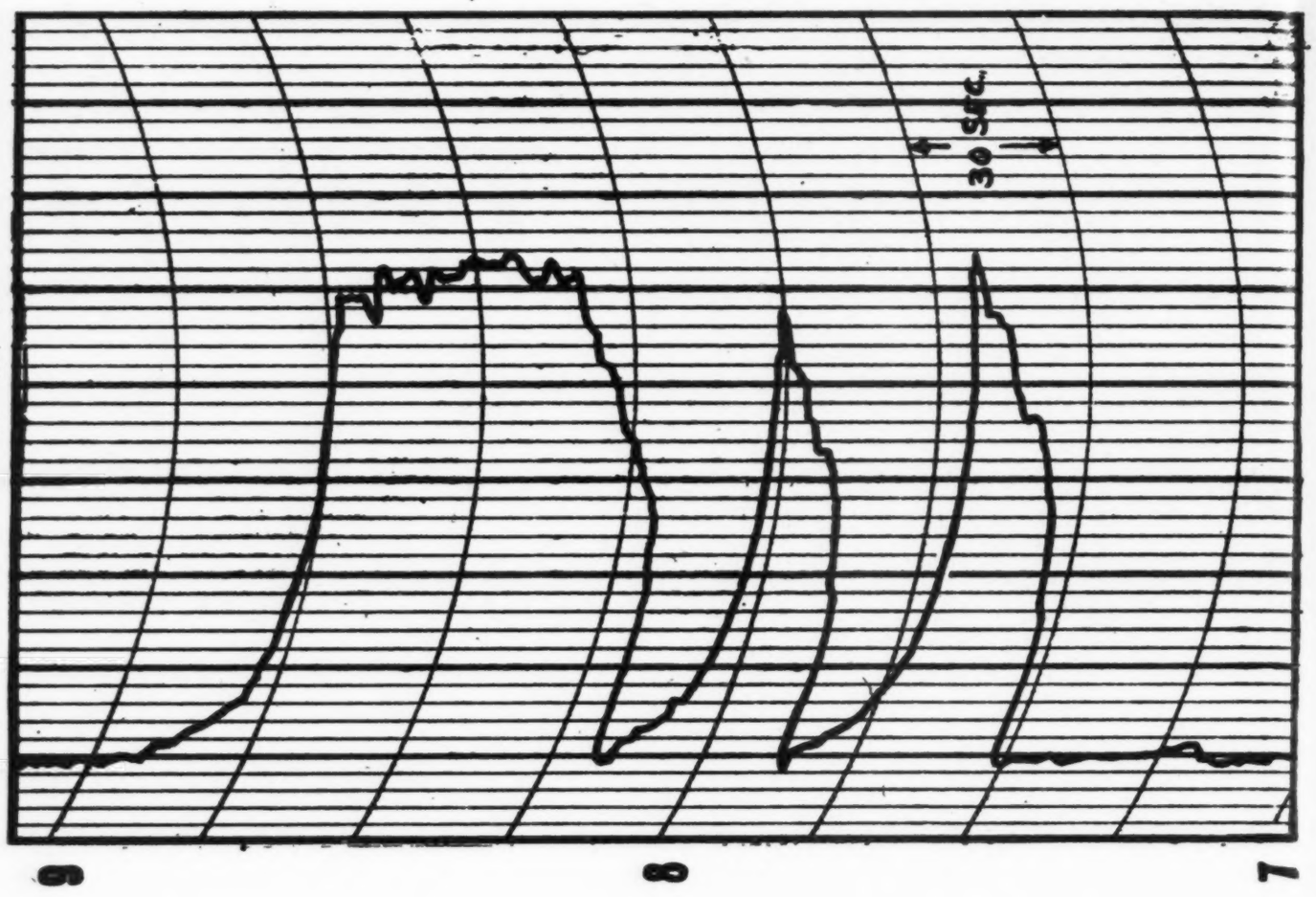


Fig. 4. Titrilog Record, showing response time.

be considered. The reference voltage is set to a value corresponding to some desired bromine concentration in the cell. The voltage is set by the "zero adjust" helipot located at left of control panel *(Fig. 1)*. The instrument is set in operation. As no bromine is present in the cell, the refernce voltage setting exceeds the sensor voltage so that the voltage is applied to the amplifier, causing it to develop bromine-generating current in the output circuit.

As bromine increases in concentration in the cell, voltage in the sensor system increases until equality with the reference voltage is approached; amplifier input and output then approach zero. Actually, in practice, where mixtures of gases are to be analyzed, gas is flowing through the cell and sweeping out bromine so that a small "zero level" current continues to flow even in the absence of titration.

This system embodies the principle of "feedback" amplification. The chemical cell is made a part of the feedback circuit. The amplifier thus operates automatically to maintain any set concentration of bromine in the titration cell. When a bromine reactive compound is absorbed from the gas stream in the cell, the bromine concentration will tend to fall, but the slightest change increases the input signal to the amplifier which responds by increasing the generation rate so that bromine is supplied to satisfy the titration demand as well as zero level concentration. Amplifier gain is high, so that the slight change in bromine level required to drive the amplifier full scale is negligible in the chemical calculation. Response is instantaneous, which in most applications is more rapid than required; hence damping components are placed in the circuit to provide required response characteristics.

A typical titration record is reproduced in *Fig. 4*. The Titrilog was operating on natural gas containing 0.6 grains total sulfur per 100 st. cu ft of gas. Two levels are shown on the chart. The lower level at 0.1 milliampere is the set "zero level" of bromine generation when no sulfur is present in the gas admitted to the cell. This zero level current is subtracted from the total current during titration to obtain the net titration current, (0.61 — 0.10 = 0.51). This current is a direct measure of sulfur concentration. Chart readings may be made directly in terms of sulfur concentration providing the bromine required per mol of the various sulfur compounds is taken into account. Titration by means of the Titrilog is truly continuous. A record of instantaneous variations in sulfur concentration is thus produced. Such variation cannot be recorded by instruments which operate automatically on a cycle comprising a period of absorption followed by a period of titration.

The rate of response of the Titrilog to changes in concentration is shown in *Fig. 5*, in which is reproduced a record of titration when the gas supply to the instrument is on for 20 seconds and off for 20 seconds. One minute of sustained titration is included in the record for comparison. The chart speed for this record was high so that the nature of the response curve could be observed. It will be noted that even under the damping conditions employed with this model, the maximum titration level for a given increase in concentration is reached in approximately 20 seconds, and that return to zero when the gas supply is cut off requires the same time.

The quantity of sulfur titrated may be calculated from the Faraday equivalent of the current, that is

(Amp. sec.) × (equiv. wt) = wt. of sulfur

For example, the equation for the reaction of an organic sulfur with bromine is given by Sease, et al[3]

$$H_2Q + RSR + BR_2 = R_2SO + 2B_r^- + 2H^+$$

The equivalent weight of sulfur, then, for this class of compound is 16. These data together with the flow rate of gas passing through the Titrilog cell permit the calculation of concentration.

The values for sulfur concentration thus obtained will be in error because of incomplete absorption of the gas and because of other minor factors. Titration efficiency studies have shown that it is necessary to calibrate the instrument for various gases of interest by titrating known quantities of gas at various titration levels. Calibration will be considered later.

Design Features

It was apparent from the early work with the laboratory models of this electronic feedback-controlled instrument that it would be well adapted to automatic continuous operation provided that the problems of stability, ease of operation, and reliability of performance could be solved. The features of design of the commercial instrument together with performance data from laboratory and field studies will show how these problems have been solved.

The location of the essential components of the Titrilog are shown in *Fig. 1* and in *Fig. 6*. The two most important components are the titration cell and the amplifier. The foregoing discussion has covered the function of each. Space will not permit discussion of the extensive research which was required to bring them to their present state of development. It is of interest, however, to

[3]Sease et al, *Anal. Chem. 90*, 431, 1948.

point out some features of design.

Amplifier. It will be noted by reference to the simplified diagram of *Fig. 2* that a 100% feed-back d-c amplifier is required for use in the Titrilog. It is further required that the zero drift be negligible and that the chemical cell be included in the feedback loop of the circuit, a condition which gives rise to new problems, particularly in stabilizing the input circuit of the amplifier. The most significant feature of the amplifier design is the conversion of the input signal to a-c by the use of a synchronous converter. Three stages of a-c amplification are then used and the output current is rectified by a second synchronous converter. The amplifier chassis is mounted directly below the recorder and carries the control panel; all connections are carried in a single cable terminating in a cannon plug for ease of servicing or replacement where necessary.

Titration Cell. The titration cell construction is of pyrex with standard ground joints and sealed-in platinum leads to eliminate possible contamination from construction materials. Cell design includes an active carbon filter between the inner and outer cell and means for circulating electrolyte continuously between the two compartments, so that reaction products produced in the titration compartment will not build up and cause trouble. The electrolyte is an aqueous solution of potassium bromide and sulfuric acid. This circulation also serves to maintain uniformity of electrolyte concentration which, if it were permitted to vary, would cause drift in the instrument zero level.

Temperature compensation is also built into the cell input circuit to the amplifier so that temperature regulation is not required for normal conditions of operation. The cell is mounted at the left in the rack shown in *Fig. 6.* The rack is easily removed or replaced as a unit.

Gas Sampling and Flow Regulation. The sample inlet system is an important part of the instrument, since the concentration range covered is determined by the sample flow rate and accuracy of measurement is dependent upon the accuracy of flow regulation. The sample flow rate is made independent of flow of gas through the cell by the process of feeding the sample into a stream of air, which is drawn through the cell by a pump on the vacuum side of the cell. This permits the cell to operate at a fairly constant flow rate determined by an orifice on the pump intake. The sample flow rate may then be set at any rate below that of the air to the cell.

The sample flow rate is determined by a replaceable orifice in the feed line. Constant pressure in the sample feed line ahead of the orifice is necessary for flow regulation; this is accomplished by admitting the sample through a needle valve at a rate in excess of the orifice capacity, the excess is permitted to escape through a fluid bubbler which contains a non-volatile fluid. The depth of fluid determines the feed pressure of the sample. Variation in the line pressure or needle valve regulation may then cause changes in the rate of gas escape through the bubbler, by amounts up to 50% of the sample feed rate without changing the feed rate in excess of 1%.

In some applications the regulating orifice may become fouled with compressor oil or other foreign matter and require occasional cleaning. A rate-checking orifice is mounted in the sample system so that it may be inserted in the line periodically in place of the regulating orifice to check the need for cleaning.

Gas Filtration. It is of interest in many applications to know the nature of the sulfur compounds titrated. Fluid filters have been developed for the selective absorption of certain classes of compounds. The design of the Titrilog includes in the inlet system a series of filters as well as solenoid-operated valves by means of which the passage of the sampled gas through various filter solutions may be controlled. These filters are mounted on a rack housing

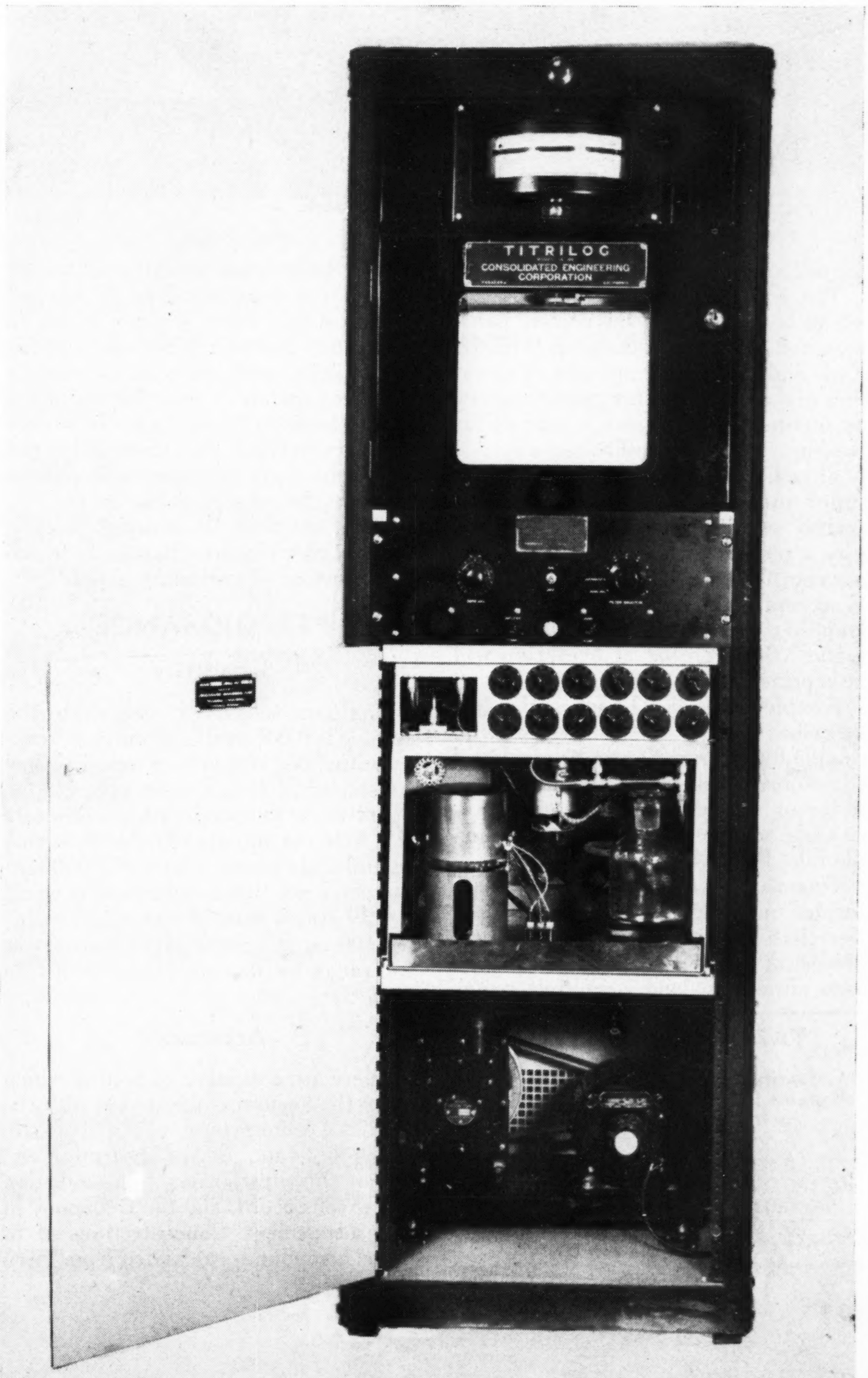


Fig. 5. Model 26-102 Titrilog with door open.

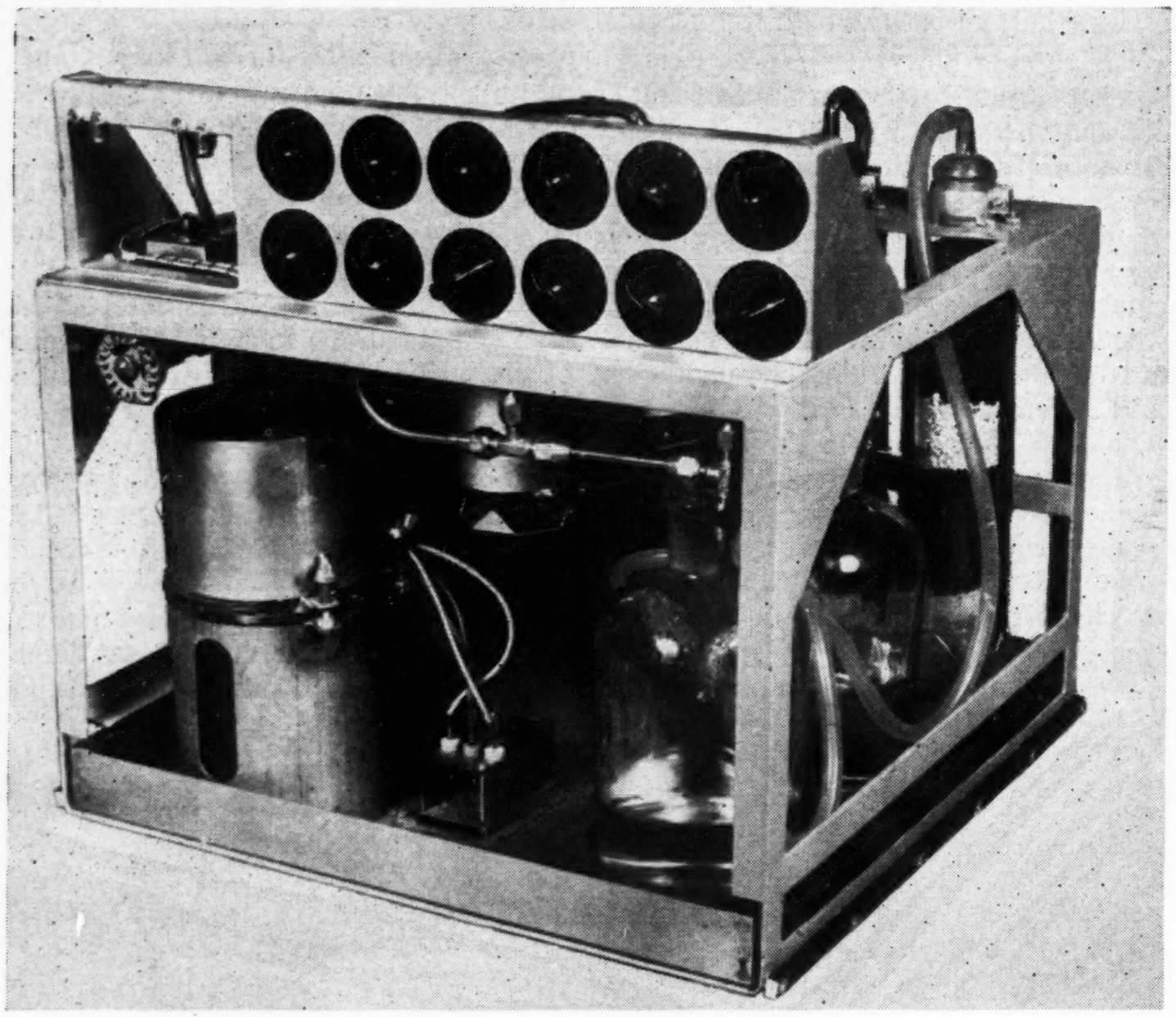


Fig. 6. Cell and filter rack.

the cell and filter assembly.

The sequence of filter operation is set up on the dials of the control panel mounted at the top of the rack *(Fig. 6)*. Each dial controls 15 minutes of operation and may be set for operation (1) on unfiltered gas, to give a total sulfur reading, (2) on gas through any one of three filters, to give a reading of total sulfur minus the contribution of the absorbed compounds, or (3) on air, to give a zero reading as a base of measurement. When the operation sequence is set and the main control dial on the amplifier control panel is set to "automatic," the program of operation will be repeated continuously.

Sample Selection. The solenoid valves described above in connection with sample filtration may also be employed in automatic selection of samples from different sources. It is only necessary to make simple alterations in the sample inlet lines.

Operating Controls. The controls are located on the front panel of the amplifier chassis as shown in *Fig. 5*. These consist of a power switch, a helipot for zero adjustment and a multiple switch selector for manual operation of the filter and gas control valves. In normal operation, the filter selector is set to automatic. The switch is "on" and the zero adjustment is set to give a reading of approximately .1 m.a. for operation at zero level on filtered air. It is only necessary to check the record daily and make any slight adjustment of zero to maintain the set zero level.

Filter solution is changed weekly. The recorder requires inking of the pen and insertion of recording paper.

TABLE 1. SENSITIVITY

Sensitivity (grains S/100 cu ft)	Range (grains S/100 cu ft)
0.005	0- 0.42
0.005	0- 0.50
0.01	0- 1.00
0.02	0- 2.00
0.10	0- 10.00
1.00	0-100.00

PERFORMANCE

Sensitivity

Maximum sensitivity achieved by the Titrilog is 0.005 grains of butyl mercaptan sulfur per 100 cu ft of gas. This low threshhold of detection is achieved by operating at the maximum gas flow rate of 1 liter per minute. At this flow rate the full-scale titration level of 0.900 milliamperes net titration current is equal to 0.39 grains of butyl mercaptan sulfur per 100 cu ft. Sensitivity decreases as the range is increased, as shown in *Table 1*.

Accuracy

There are a number of factors which affect the accuracy obtainable with the Titrilog. Among these are the control of gas-flow rate, the gas-absorption efficiency, the titration level, the duration of a given record, and the frequency of zero adjustment. Concentrations of titrated compounds calculated from Titrilog records are also dependent upon the accuracy of calibration data for the compound. The production of known concentrations of odorous compounds in the extreme dilution required for calibration has been a difficult problem. The most reliable calibration procedures (which will be discussed in a forthcoming publication) have been those based upon the continuous feed of regulated amounts of sulfur compound into a continuous stream of gas or air from which the Titrilog is supplied. By this means, surface adsorption effects are minimized and direct determination of feed rate can be made by gravimetric procedures.

Calibration data for a Titrilog cell operating on pure butyl mercaptan are given in *Table 2* for a period of 28 days. Periodic automatic recording of zero eliminates zero drift as a source of error, since detectable drift does not occur over a period of three hours and is usually negligible for periods of from 72 to 100 hours. It is believed that the over-all data are reliable to approximately $\pm 5\%$ at titration levels above midscale. The data available for presentation at this time make possible the evaluation of the instrument for a number of applications. Changes of concentration occurring during shorter periods of one day, for example, are recorded with much better accuracy.

Compounds Titrated and Calibration Data

The compounds thus far studied have been the sulfur compounds commonly present in fuel and process gas, and the compounds which might be expected to interfere with sulfur determination.

The following compounds of sulfur have been titrated: sulfur dioxide, hydrogen sulfide, mercaptans through amyl mercaptan, thioethers, thiophene, and disulfides.

Compounds which have been tested and found not to be titrated are: carbon monoxide, aldehydes and ketones, carbon disulfide and carbonyl sulfide.

TABLE 2. TITRILOG CALIBRATION FOR BUTYL MERCAPTAN

Run No.	Net Titration	Eq Br_2 per mol Mercaptan
1-10-1	0.22	2.53
2	0.26	2.51
3	0.35	2.36
4	0.42	2.37
5	0.53	2.28
6	0.69	2.13
7	0.64	2.27
8	0.74	2.06
1-12-1	0.67	1.99
1-13-1	0.88	1.88
2	0.53	2.16
3	0.44	2.40
4	0.36	2.36
5	0.23	2.43
6	0.19	2.46
2- 8-1	0.38	2.37
		average: 2.29

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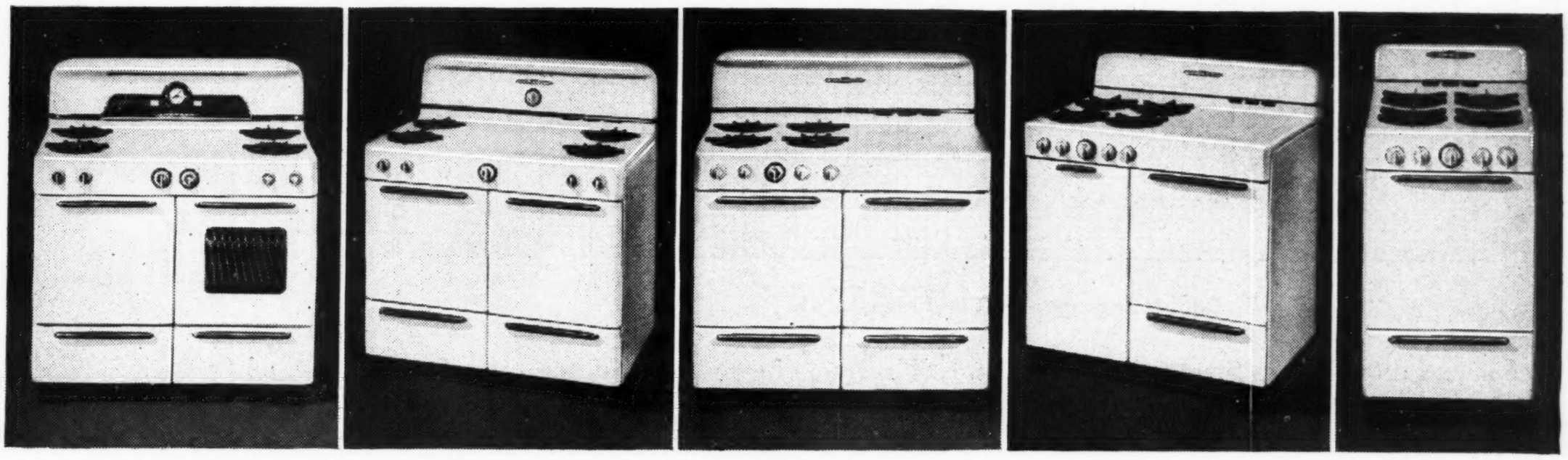

Model GA-44 Model GA-42 Model GA-40 Model GA-30 Model GA-20

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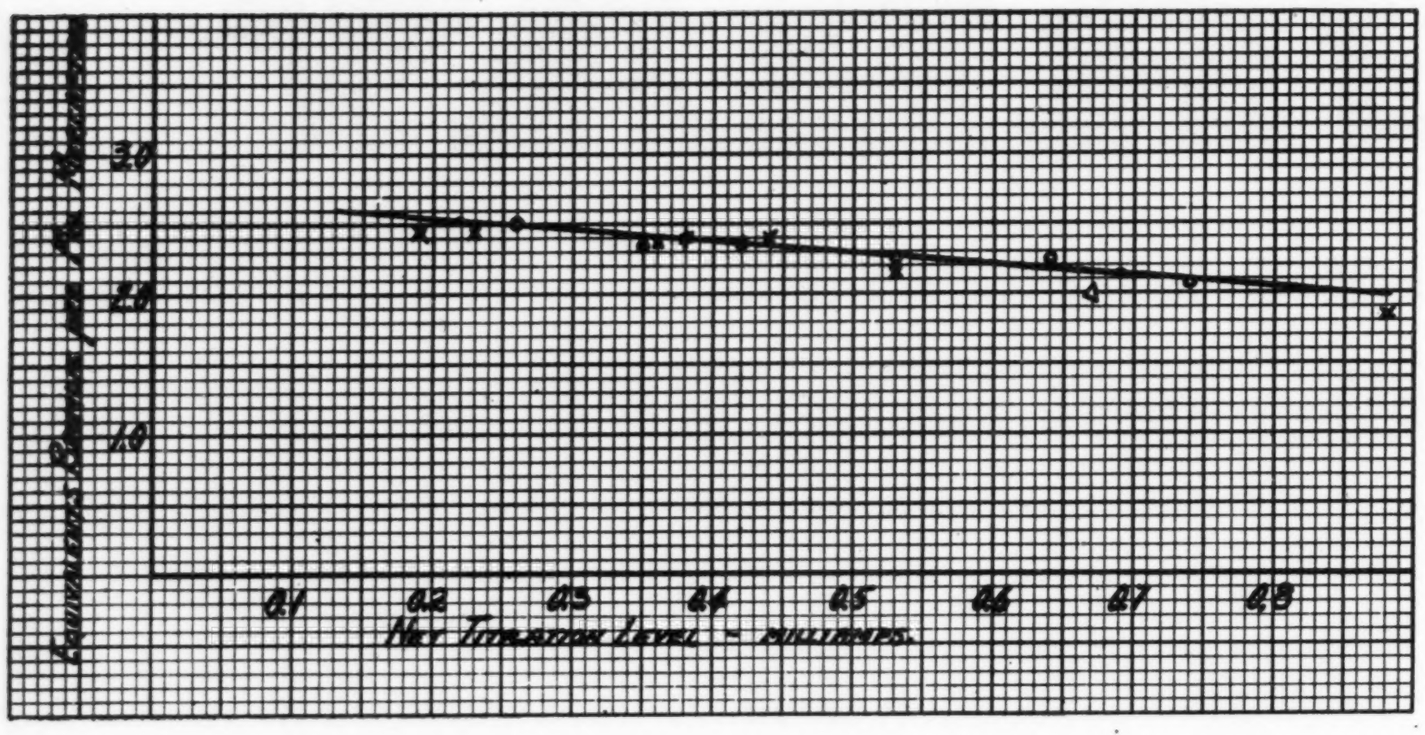


Fig. 7. Calibration curve for Butyl Mercaptan.

Olefins and diolefins are titrated in the standard cell to a very limited extent. These unsaturated compounds therefore interfere with sulfur determination by direct titration only where their concentration is over 100 times the concentration of titrable sulfur compounds. Carbon disulfide and carbonyl sulfide are not titrated directly but may be converted by combustion to SO_2 and then titrated.

The bromine required per mol for oxidation of a given sulfur compound is calculated from the weight of the compound fed to the Titrilog and from the recorded bromine-generating current. Data for BB dichlorodiethyl sulfide $(ClCH_2CH_2)_2S$ are given below.

Time of titration: 92 min.

Net titration current: 0.78 m.a.

Wt. BB dichlorodiethyl sulfide: 0.00373 gm.

$$\frac{\text{Sample wt.}}{\text{Mo. wt.}} = \frac{0.00373}{160} = 2.33 \times 10^{-5} \text{ mols}$$

$$\frac{\text{Amp.} \times \text{sec.}}{96500} = \frac{0.78 \times 92 \times 60 \times 10^{-3}}{96500} = 4.47 \times 10^{-5} \text{ eq. } Br_2$$

$$\frac{4.47}{2.23} = 1.95 \text{ eq. } Br_2 \text{ per mol } (ClCH_2CH_2)_2S$$

This value is only slightly below the value of 2, which should be obtained if absorption were complete and oxidation quantitative. Bromine requirements for some of the other compounds thus far studied are given in *Table 3*. These data have been obtained at approximately the same titration level. Purity of samples was checked by analysis, using the Consolidated Model 21-102 mass spectrometer.

These data show a considerable variation in the amount of bromine required per atom of sulfur for the various compounds. The ratio of equivalents of bromine to mols of sulfur compound does not approximate a simple whole number. It has been found that this is largely due to the fact that, in the titration of the compounds of *Table 3*, absorption of these compounds in the titration cell is not complete. A fraction of the sulfur compound passes or "slips" through the cell untitrated. It has been necessary, for calibration of the instrument, to show that the efficiency of absorption and titration of a given compound remains the same over long periods of operation of the cell and is not affected by the titration of other compounds in the intervening time. Extensive data have been obtained in this study. The data for butyl mercaptan are typical; they are given in *Table 2;* plotted in *Fig. 7.*

It will be noted that the points fall very near a straight line, which shows a somewhat higher efficiency of titration at lower titration levels. Data for the same day are plotted with the same sign. Though the period of the study was 28 days and the cell was operated on other compounds during the period, no significant change in titration efficiency was noted. Deviation of points from the line is not great, the maximum being —6.5%. The average deviation is approximately ±2.3%.

TABLE 3. BROMINE REQUIREMENTS

Compound	Eq. Br_2/mol
Butyl mercaptan	2.30
Dimethyl sulfide	1.62
Dimethyl disulfide	6.00
Ethyl mercaptan	3.27
Methyl mercaptan	4.07

TABLE 4. TITRILOG CALIBRATION FOR DIMETHYL SULFIDE

Run No.	Net Titration (ma)	Eq. Br_2 per mol Dimethyl Sulfide
2-2-1	0.69	1.68
2	0.68	1.59
3	0.48	1.58
4	0.44	1.34
2-3-1	0.36	1.69
2	0.35	1.51
3	0.29	1.27
4	0.42	1.57
5	0.54	1.72
6	0.68	1.61
7	0.78	1.90
2-4-1	0.75	1.90
2	0.68	1.71
3	0.79	1.99
4	0.57	1.71
5	0.32	1.49
6	0.18	1.31
	average:	1.62

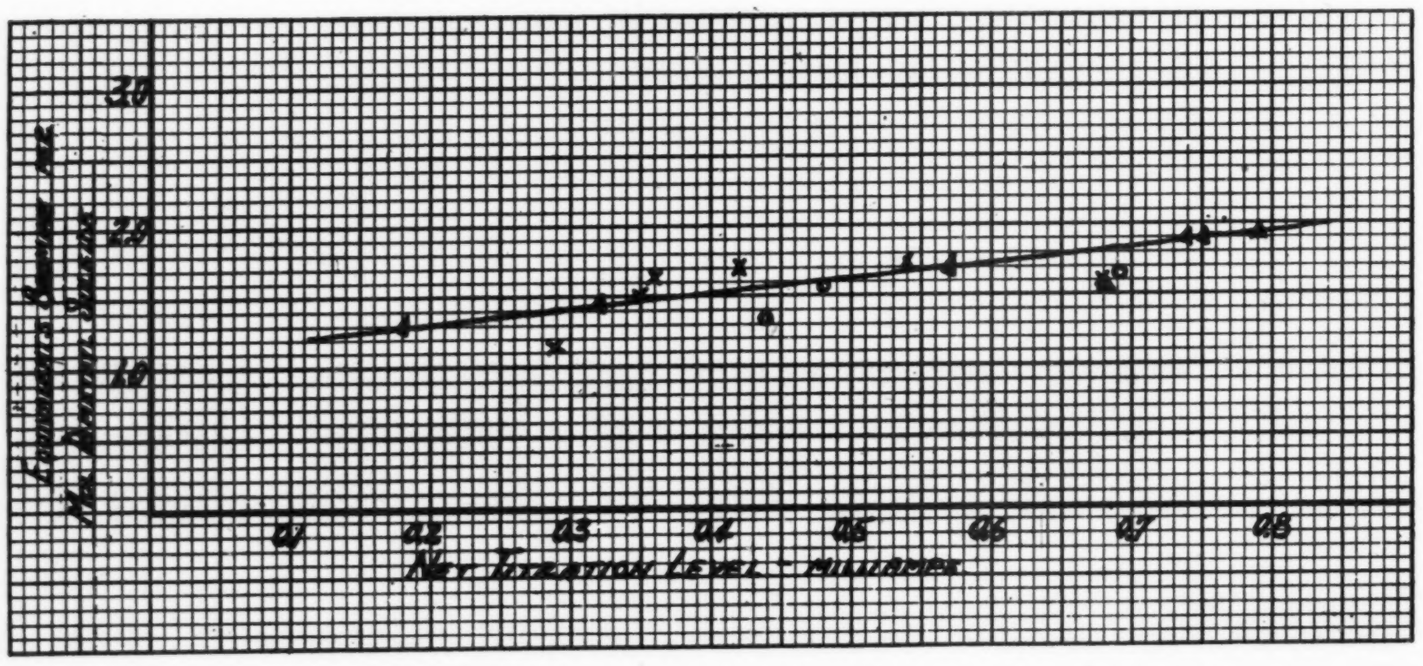
It should be noted that where mixtures of mercaptans are present in the gas it is necessary to determine approximate composition of the mixture in order to accurately interpret data for mercaptan concentration. In gas odorization, calibration runs with the Titrilog are easily made on the actual commercial odorant. Where natural mercaptans are present in field gas, Titrilog data can be checked against careful chemical analysis to determine approximate mercaptan composition.

Experimental work now in progress shows marked solubility of higher mercaptans, which will improve data for determination of mercaptan sulfur in mixtures of mercaptans.

Data for titration of dimethyl sulfide are given in *Table 4*. These data are plotted in *Fig. 8*, with the same symbol used for data taken on the same day. It will be noted that the dispersion of the plotted points is greater than for butyl mercaptan but the dispersion is not correlated with time. This indicates that there is no serious efficiency change.

Adsorption in the gas-mixing lines was suspected and work done to improve conditions. The data for the last run after this improvement are plotted

Fig. 8. Calibration curve for dimethyl sulfide.



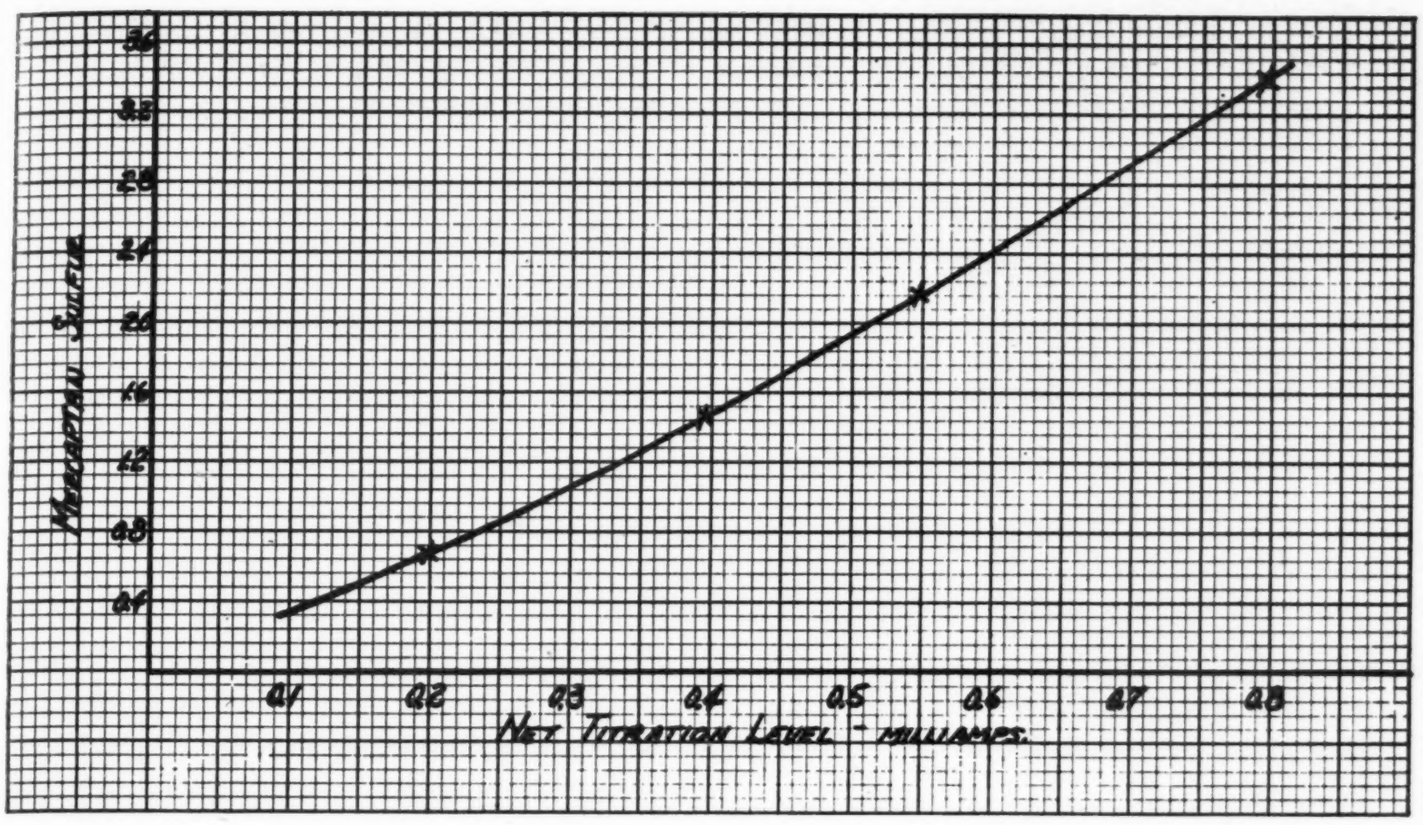


Fig. 9. Grains sulfur per 100 st. cu ft. Mercaptan sulfur calculated as sulfur.

with triangle signs. The line is drawn through these data, only one point of which falls off the line. Additional work will be required to check more fully the behavior of the sulfide. It will be noted that the bromine required increases with increasing titration level. This behavior is not yet explained.

Slip data not yet complete indicate that the reaction is to sulfoxide, which requires 2 eq. bromine per mol.

The calculation of the concentration of compounds for which the Titrilog has been calibrated is very simple. The net titration crurent is multiplied by an instrument factor which takes into account the bromine required per mol of titrated compound, for oxidation, the over-all solution and reaction efficiency, and the gas sampling flow rate. The general calibration data are obtained by titration of weighed quantities of pure compound.

For example, with the instrument operating at a flow rate of 100 st. cc/min. and a net titrating current of .5 ma., the concentration of mercaptan sulfur as sulfur in the sample is 1.91 grains/100 st. cu ft. Then for a given operating instrument of set flow rate the factor will be

$$\frac{100\ (1.91)}{(0.5)\ (\text{gas feed flow rate})} = \frac{382}{\text{st.cc. min. (flow rate)}}$$

Then, for example, an instrument operating at a flow rate of 220 cc

$$\frac{382}{220} = 1.74$$

A reading of .62 m.a. on this instrument record would then correspond to .62 × 1.74 = 1.08 grains S per 100 st. cu ft. This procedure is followed where the accuracy of an average factor such as the above value taken from a mean titration level of 0.50 m.a. is sufficient. For greater accuracy a graph is made in which sulfur concentration is plotted against net titration current. Such a graph is shown in *Fig. 9*.

Field experience with the Titrilog has extended over a period of over two years. The Titrilog 26-102 embodies in design many features that were proven in the field during the early months of the study. Among these is the use of selective filters for the absorption of certain classes of compounds.

The location and function of these filters has been described in the treatment of design.

A reproduction of a typical record, made in operation on Texas natural gas, is shown in *Fig. 10*. The filter solution, in this case, was alkaline cadmium sulfate, which is employed to remove hydrogen sulfide and mercaptans. The data for the record are as follows:

Zero level = 0.095 m.a.
Total titration level = 0.55 m.a.
Titration level (through filter) = 0.20 m.a.
Mercaptan factor = 1.74

Since the alkaline cadmium sulfate removes mercaptans and H_2S, the concentration of these components is indicated by the difference between the total titration level and the titration level (through filter)—i.e., 0.55 m.a. minus 0.20 m.a. = 0.35 m.a.

To obtain the concentration of mercaptan as sulfur, one could simply read the value directly from a graph (such as *Fig. 9)* or calculate it, using a conversion factor as follows:

(Net titration level) (factor) = grains sulfur per 100 st. cu ft.

(0.35) (1.74) = 0.608 grain sulfur per 100 st. cu ft.

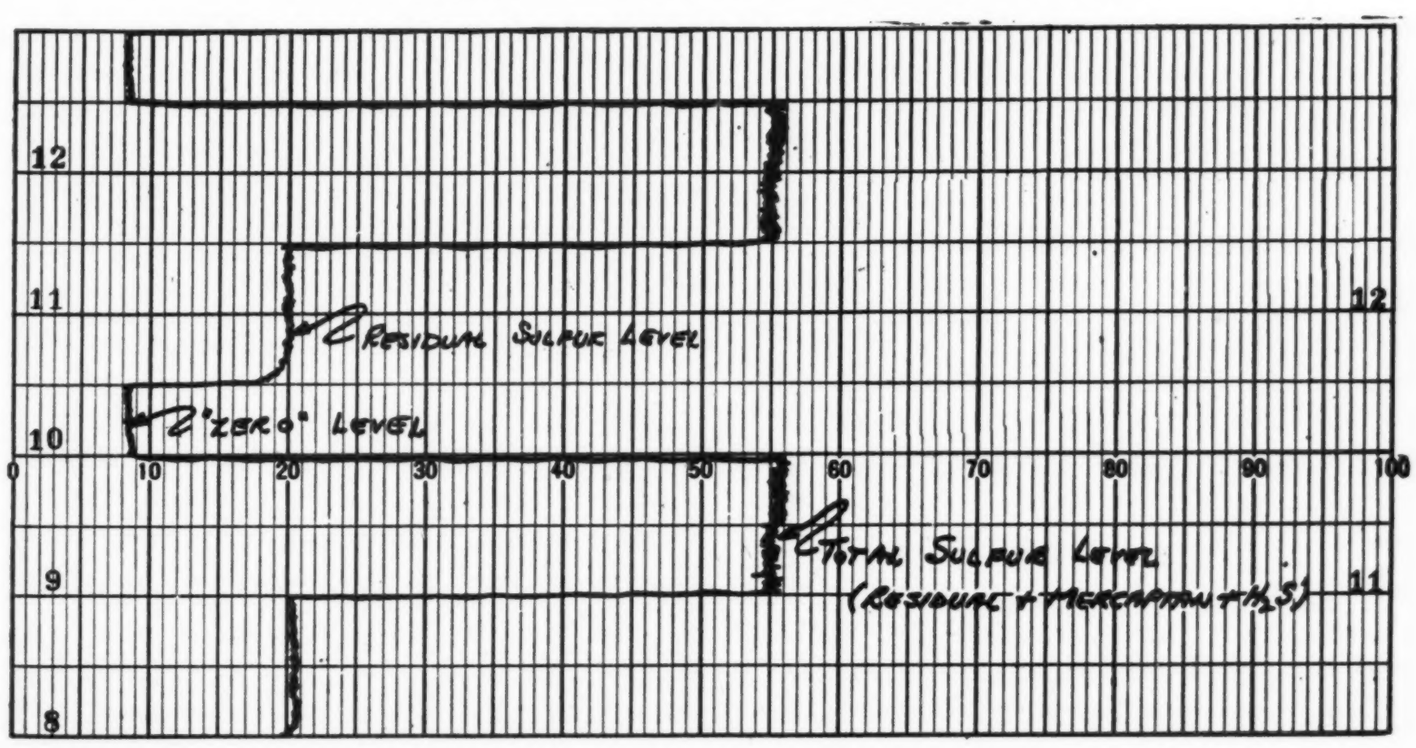
This procedure may be followed for other compounds as filter techniques are developed for this separation.

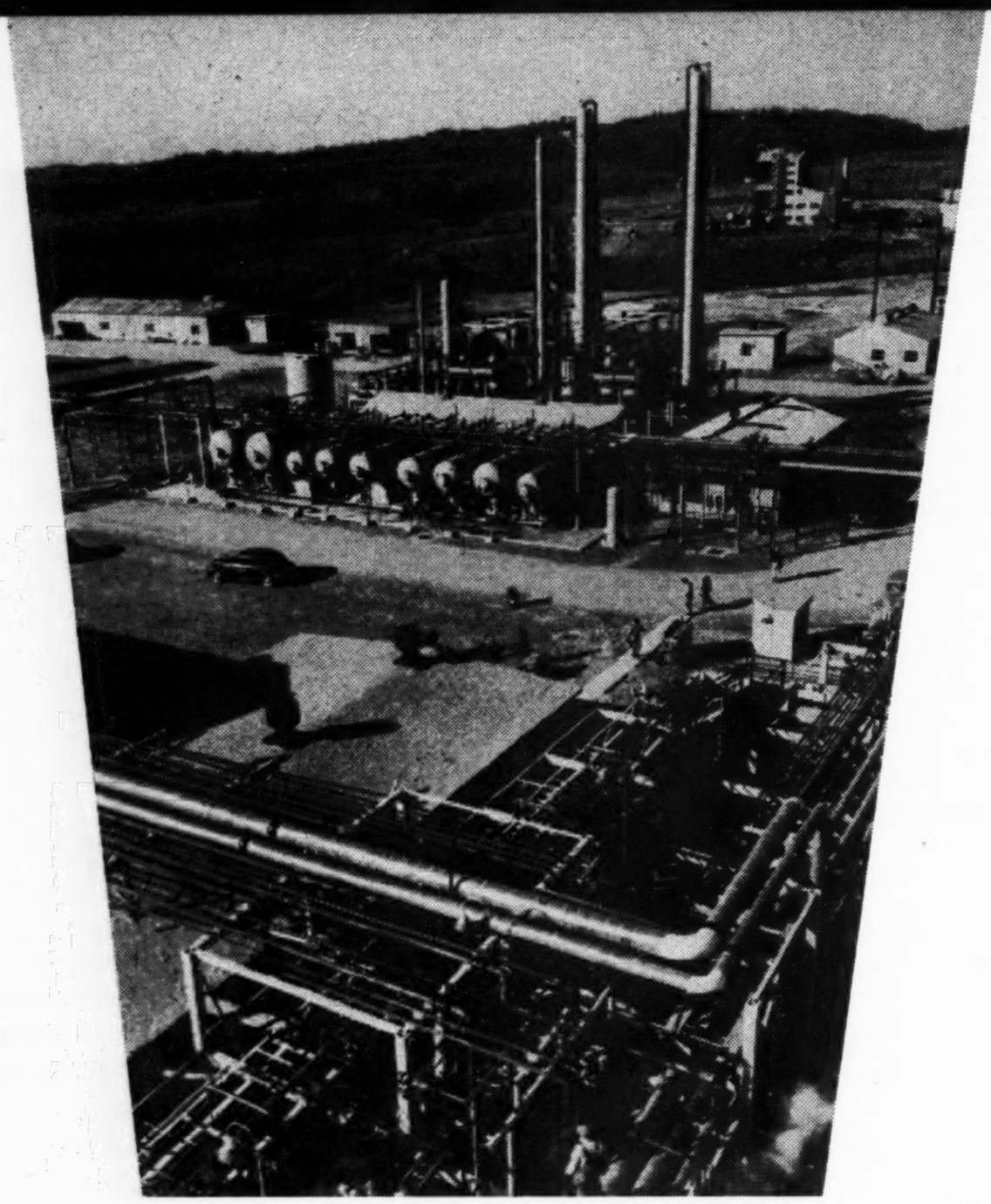
To summarize:

A new method has been developed for the automatic continuous titration of sulfur compounds in gas streams, which is based on the application of electronic control to the titration reaction. The Titrilog is a commercial instrument in which this new principle is utilized. It is designed for use in the laboratory or in the field and will operate for extended periods without attention so that installation in isolated locations is entirely practical. Sensitivity of the Titrilog is very high so that studies of sulfur concentrations in the lowest ranges of interest are easily made. Concentration is measured in terms of electrical current which is continuously recorded by a strip chart recorder contained in the instrument. The data are easily interpreted and may be converted to actual concentration in conventional units by the simple application of a multiplying factor for the various compounds measured.

The second part of this paper will appear in the next issue of GAS. It will be devoted to the actual field use of the Titrilog in the solution of problems to which it has been successfully applied. These problems are found in the pipeline transmission of gas, in the processing of gas or removal of sulfur, in the distribution and odorizing of natural gas, in testing and evaluating of odorants, and in the study of the distribution of sulfur in natural gasoline plant streams.

Fig. 10. Typical Titrilog Record for natural gas operation.





DISTILLATION AREA, background, U. S. Bureau of Mines hydrogenation demonstration plant, Louisiana, Mo.

Byproduct Hydrocarbon Gases

. . . they will be an important factor in supplying the fuels market of the future.

By PETER W. SHERWOOD

VAST new potential sources of hydrocarbon gases are opening up as America's synthetic liquid fuels industry takes on reality.

Exclusive

Heralded in some quarters, received coldly in others, the development of synthetic fuels processes is becoming an increasingly important factor in the country's long-range energy prospects. Process improvements of recent years and expected unfavorable developments in petroleum's demand-supply ratio seem to forecast economic soundness for the manufacture of automotive hydrocarbon fuels from natural gas, coal, and oil shale in the not too distant future.

Of these three available alternate sources for gasoline and fuel oil production, natural gas is the one most immediately competitive to petroleum. Now nearing construction at Brownsville, Texas, is America's first commercial plant for the production of gasoline from natural gas by a version of the Fischer-Tropsch process.

The long-range view minimizes the significance of natural gas as a source of liquid hydrocarbons. Domestic and industrial heating installations already consume usefully some 70% of the annual natural gas production. Another 10 to 12% is converted to carbon black and to a variety of chemicals ranging from carbon tetrachloride to ammonia. The remaining natural gas, now wasted, might, take up a slack not exceeding 2 to 4% of the U. S. petroleum demand.

When the country's synthetic fuels industry eventually reaches significance, be it for economic or strategic reasons, it will therefore most certainly be primarily based on coal and shale oil.

Two fundamental processes for the conversion of coal to liquid fuels show sufficient economic soundness to merit inclusion in the long-range program. The Fischer-Tropsch process converts carbon monoxide and hydrogen catalytically to a complex mixture of hydrocarbons ranging all the way from methane to very high-melting waxes. In this process, the costliest single production item is the initial CO-H_2 mixture, raw material for the process. Manufactured most readily and cheaply from natural gas, it can also be produced by the gasification of coal and coke either in standard water gas machines or, preferably, in continuous units of the types developed by Koppers, Winkler, or Lurgi.

The alternate approach to the conversion of coal involves its direct liquefaction by the application of hydrogen at pressures ranging from 4000 to 10,300 psi and at a temperature of about 900°F. High-pressure hydrogenation for the production of gasoline from coal must be carried out in two stages: a slurry-like liquid phase which yields a middle oil of average molecular weight 200, followed by a vapor phase in which middle oil is converted to a highly aromatic and knock-resistant gasoline (average molecular weight about 100) in the presence of a fixed-bed catalyst. High-pressure hydrogen is present in both stages of the process.

These two basic synthesis processes are complementary in the nature of their products and the scope of their application. A sound synthetic fuels industry must look to both production methods.

America's fortunate possession of immense oil shale deposits in the Colorado-Utah-Wyoming region permits inclusion of this valuable raw material in the development of supplemental sources of liquid fuels. Criteria for the economic usefulness of oil shale are the cost of mining, specific oil content (in Colorado shale this is about 30-35 gals. per ton), heat economy and expense of the extraction process and refining methods.

A study by the U. S. Bureau of Mines indicates that shale mining and transportation costs need not exceed 58 cents per ton, a figure deemed to be well within the economic range.[1] Extraction processes considered most suitable for U. S. conditions, involve destructive distillation at temperatures above 950°F. Carbon deposits left on the extracted shale are burned off in a separate stage and the evolved heat is employed for the distillation step. Refining methods may be akin to the normal extraction and cracking processes practiced in the petroleum industry. Much better yields are, however, obtained by high-pressure hydrogenation of the distilled shale oil in a manner similar to that described above in connection with coal liquefaction. The question of refining by less efficient cracking vs. hydrogenation in more costly installations must be resolved by economic considerations.

Importance to Gas Industry

All of the synthetic liquid fuels processes here described yield very appreciable quantities of byproduct hydrocarbon gases. Attempts are made to keep the formation of these gases at an absolute minimum because they not only reduce the yield of the more valuable hydrocarbon liquids but also because they

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TABLE 1. AVERAGE BYPRODUCT YIELD PER BARREL OF GASOLINE FROM CRACKING

	Mixed-Phase Cracking	Reforming	Vapor-Phase Cracking	Catal. Cracking
Gas Yield, Cu Ft per bbl gasoline (E.P. 400°F, 10 lb)	750-850	800-1075	1600-2000	600-825
Gas Composition				
Hydrogen	3	7	7	7
Methane	35	40	30	18
Ethylene	3	4	23	5
Ethane	20	18	12	9
Propylene	7	6	14	16
Propane	15	10	4	14
Isobutane	2	3	1	16
n-Butane	8	7	2	5
Butenes	7	5	6	10
Butadienes			1	

are particularly wasteful of costly hydrogen. Nevertheless, the unavoidable formation of LP-Gases, ethane, and methane is large enough to cause a significant impact on the gas transmission and bottled gas industries once the synthetic fuels industry gets fully underway.

The bulk of today's hydrocarbon gases are derived from natural gas and petroleum refinery gases. Natural gas encountered in the oil fields of the United States contains predominantly methane in amounts usually varying between 80 and 98%. Liquefied petroleum gases (notably propane and butane) are present in appreciable quantities in some natural gases. Their recovery along with natural gasoline is an important industrial operation, which accounted for some 30 million bbls of LP-Gases in 1946. Hydrogen sulfide and carbon dioxide are also not infrequently present in natural gas and must be scrubbed out prior to transmission, often without compensation other than the removal of a nuisance, but sometimes with monetary returns for the sale of byproduct carbon dioxide and sulfur.

A wide variety of byproduct gases is formed in the course of the standard distillation and cracking processes of petroleum refineries. Some of these, notably the olefins, isobutane, and n-butane are being increasingly used within the refinery for chemical purposes. Appreciable quantities of these byproduct gases are, however, being made available to the gas industry. Their propane and butane content are the mainstay of the bottled gas industry. The methane and ethane components, on the other hand, yield an important addition to the gas transmission industry.

Composition of the available hydrocarbon gases depends primarily on the method of processing and, to a much lesser extent on the feedstock being processed. *Table 1* shows average yield per barrel of gasoline produced and chemical composition of byproduct gases formed in the course of several petroleum refining processes of importance.[2]

These values are presented for the sake of comparison with the gases formed as byproduct in the manufacture of synthetic fuels which are here discussed and which will be seen to have a pronouncedly individual character, varying widely with the process in the course of which they are formed.

Fischer-Tropsch Gases

Byproduct gases formed in the course of the Fischer-Tropsch synthesis depend to a great extent on the nature of the catalyst employed as well as on the interrelation of operating temperature and carbon monoxide-hydrogen ratio in the synthesis gas, operating pressure, and converter design. The present brief study will of necessity be confined to some typical results obtained in the more important versions of the process.

A striking characteristic of the gas formed during the Fischer-Tropsch process, regardless of catalyst employed, is the high olefin content and the comparatively small amount of C_2 hydrocarbons formed. The chemical attractions of byproduct ethylene, propylene, and butene present are sufficiently obvious. They may not be expected to add to the resources of the gas industry. Paraffinic hydrocarbons are, however, present in sufficient amounts to represent a formidable hydrocarbon gas potential.

German wartime production of Fischer-Tropsch hydrocarbons was carried out almost solely in the presence of cobalt catalysts. The olefin content of the entire range of products formed under such conditions is greatly dependent on the carbon monoxide-to-hydrogen ratio, whereby a high ratio means automatically a highly olefinic product. Normally, the olefin content may vary between 25 and 60%.

Theoretical yield per thousand cu ft $CO + H_2$ is 13 lb of primary products (i.e. the entire system of solid, liquid, and gaseous hydrocarbons formed). Actual yields obtained even under the most favorable circumstances do not greatly exceed 80% of theory. Normal-pressure synthesis results in the formation of C_1 and C_2 hydrocarbons to the extent of about 16% of the total. Almost all of this permanent gas formation is methane. C_3 and C_4 hydrocarbons are more evenly distributed in the LP-Gas products which amount to some 11% of the total hydrocarbon production.[3] At operating conditions normally employed in industrial usage, the propane-butane fraction formed at atmospheric pressure has an olefin content of 45%.

A few German plants operated at least a section of their total converter volume at a pressure of 150 psi. Here, too, a cobalt catalyst was employed. One effect of this change in reaction pressure is to displace the entire product spectrum in favor of compounds of higher molecular weight. Accordingly the methane formation is reduced to 14% while the LP-Gases total 6% under these conditions; olefin content of the latter is 40%.

More important from the point of view of U. S. industry is the Fischer-Tropsch synthesis in the presence of *iron* catalysts. One major advantage is the formation of large amounts of valuable byproduct oxygenated chemicals, notably alcohols, ketones, aldehydes, and acids. Moreover, the cheaper and more rugged iron catalysts are better suited for the fluidization developed in the U. S. for hydrocarbon synthesis.

Olefin content of the products formed in the presence of iron catalysts depends on exact history of catalyst manufacture and may vary between 20 and 80%.

The effect of catalyst composition on total hydrocarbon gas formation is sim-

TABLE 2. GASEOUS PRODUCTS YIELD PER 100 LB OIL

	Permanent Gases ($C_1 + C_2$)	LP-Gases ($C_3 + C_4$)
Catalyst A	26.2 lbs.	31.4 (53% olefins)
Catalyst B	14.0	26.0 (66% olefins)
Catalyst C	10.6	12.0 (77% olefins)
Catalyst D	25.8	27.7 (71% olefins)
Catalyst E	18.9	19.9 (62% olefins)
Catalyst F	27.9	35.0 (53% olefins)

GAS SYNTHESIS demonstration plant, U. S. Bureau of Mines, Louisiana, Mo. Plant converts coal to oil using Fischer-Tropsch process.

ilarly pronounced. In a classical comparative series of tests carried out at Schwarzheide,[4] six different catalysts were exposed to similar synthesis conditions. The reaction was carried out in a single stage in each case and yields were accordingly lower than is possible in industrial multi-stage or recycle processes. Total yield of hydrocarbons varied between 7.4 and 9.0 lbs/Mcf ideal synthesis gas (i.e., $CO + H_2$). *Table 2* shows the amounts of gaseous products obtained per 100 lbs oil.

In addition to the nature of the catalyst, operating conditions such as contact time and temperature, are found to influence gas formation and composition significantly. A catalyst similar to Catalyst D in the above tabulation was employed for the so-called hot gas recycle process which is characterized by particularly short contact times. The process was carried out in two stages.[5] Under these conditions the make gases totalled 44 lbs permanent gases and 31 lbs LP-Gases (80% olefinic) per 100 lbs oil. Much lower gas yields were obtained in the operation of the so-called "liquid-phase" process with a like catalyst. This latter process is characterized by high yields of liquid products.

It is clear from the above figures that wide variations may be expected in the quantities available to the gas industry as byproducts of the Fischer-Tropsch synthesis. As an average expectancy the permanent gas production should amount to about 1000 cu ft per bbl (42 gals.) total oil yield. At the same time, the bottled gas industry will boost its supply of LP-Gases by some 150 cu ft per bbl oil produced. Another 180 cu ft of propylene and butene will become available for chemical processing.

The permanent gases which become available as byproducts of the Fischer-Tropsch synthesis are, of course, no little diluted by unconverted hydrogen, carbon monoxide, some nitrogen, and carbon dioxide. A small percentage of some inert, such as nitrogen or methane, in the initial synthesis gas will show up as a large portion of the tail gas due to shrinkage of the total gas volume. This realization opens the way for the Fischer-Tropsch process using a synthesis gas rich in methane, of the type produced in the course of gasification under pressure. This type of gasification process is attractive because it eliminates the need for costly gas compression but it has the disadvantage of converting a sizable portion of the coal feedstock to methane which is of no immediate use in the Fischer-Tropsch synthesis. Such a starting gas will, however, yield a tail gas of sufficient heating value to permit its economic long-distance shipment without the need for expensive enrichment processes. The value of this procedure is questionable for the present U. S. economy but it deserves consideration for its latent potentialities. For a more detailed discussion of this approach to the Fischer-Tropsch synthesis, the interested reader is referred to a recent paper by Dorschner.[6]

Table 3. Byproducts of Coal Liquefaction

	vol. per cent
Methane	47
Ethane	23
Propane	21
Butane	9*
Total	100

* (about one-quarter of the butane content is isobutane)

Coal Hydrogenation Gases

Gases obtained in the course of high-pressure hydrogenation processes for the synthetic production of liquid fuels differ markedly from the gaseous byproducts of the Fischer-Tropsch process in the complete absence of olefins.

The two phases of the hydrogenation process yield byproduct gases in unequal amounts. The larger portion is derived from the primary liquefaction stage which is not as susceptible to close control as the vapor phase. While every attempt is made to minimize gas formation, economic compromises required on an industrial scale result in the formation of very appreciable quantities of byproduct hydrocarbon gases.

Composition of the gas formed in liquid phase operation is surprisingly independent of the feedstock employed and of operating conditions. The analysis in *Table 3* is typical for byproduct gases formed during coal liquefaction.

The gas quantity is, on the other hand, determined by the time-temperature conditions extant in the reactor which, in turn, depend on the ease with which the feedstock can be hydrogenated. The largest amount of gas formation is encountered in bituminous coal liquefaction which calls for particularly drastic operating conditions. Very low gas formation is associated with the conversion of such readily hydrogenated materials as petroleum topping residue. This effect of raw material on amount of gas formation is strikingly illustrated by the industrial hydrogenation data[7] shown in *Table 4.*

Much smaller amounts of gas are

Table 5. Typical Vapor Phase Byproduct Hydrocarbon Gases

	vol. per cent
Methane, Ethane	8
Propane	20.3
Butane	71.7

TABLE 4. INDUSTRIAL HYDROGENATION DATA

Raw Material	Operating Pressure	Gas Formation Wt. % of Fresh Feedstock
Bituminous Coal	10,000 psi	20.5
Bituminous Coal	4,250 psi	24-25
Lignite	10,000 psi	18.4
Lignite	3,750 psi	15.2
Lignite Low-Temp. Tar	4,250 psi	17-18
Coke-Oven Tar	4,250 psi	21.5
Petroleum Topping Residue	10,000 psi	12.0

formed in the course of the vapor phase. Methane and ethane formation can be kept at a value below two per cent of the feedstock weight. The simultaneous formation of propane and butane raises the total gasification to about 12%. A typical vapor phase byproduct hydrocarbon gas might analyze* as shown in *Table 5*.

The C_4-fraction from both operating stages is particularly notable for its high isobutane content. This compound is too valuable for the production of antiknock gasoline to permit its sale to the bottled gas industry. The U. S. Bureau of Mines estimates that some 8,500 bbls propane and n-butane will become available as byproduct of the manufacture of 20,000 bbls gasoline by coal hydrogenation of a Pittsburgh seam coal.[8] These byproduct gases are expected to carry a large share of the economic burden of the process as long as a suitable market exists for them.

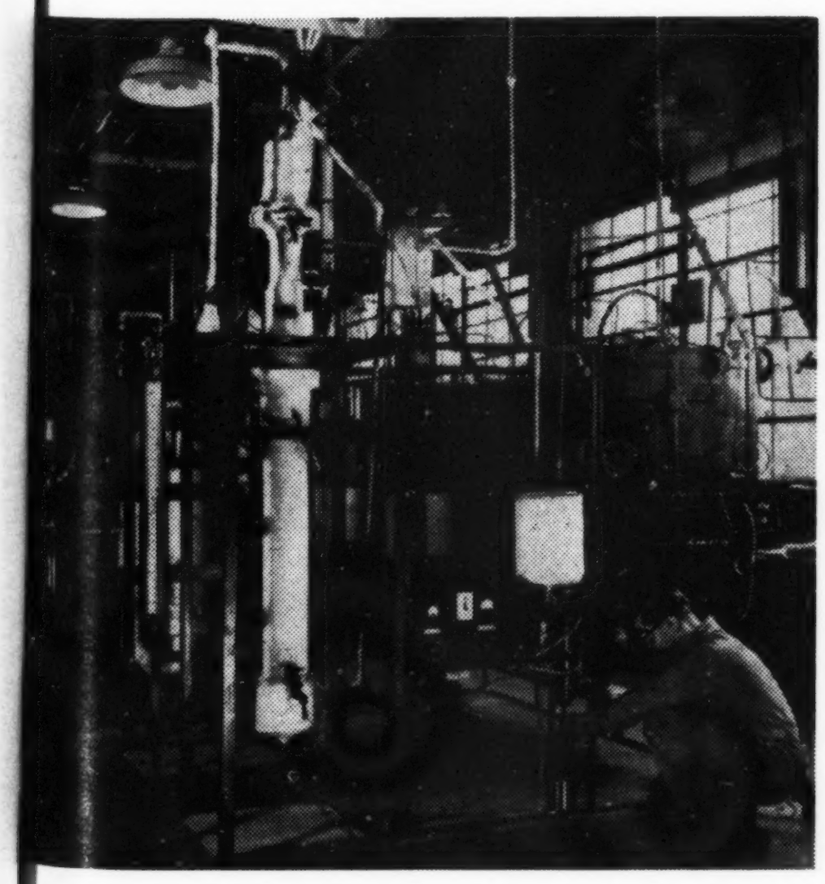
Table 6. Analysis of "Hy-Gases"

Component	vol. per cent
Hydrogen	8
Methane	57
Ethane	28
Propane	3
Carbon Monoxide	2
Inerts	2
Total	100

Unlike the dilute Fischer-Tropsch tail gases with an average heating value of only 650 Btu/cu ft, the permanent gases leaving coal hydrogenation are sufficiently rich (1065 Btu/cu ft) to justify their cross-country transmission. *Table 6* is an analysis which is typical for these "Hy-gases" which will eventually become available to the gas industry.[9]

*Gasoline end point is assumed at 180°C. Vapor-phase operation is at 4250 psi in two stages.

STATIC-BED slurry unit for hydrocarbon synthesis at Bureau of Mines laboratory, Bruceton, Pa.



Sulfur content is less than 10 grains per 100 cu ft. The gas is available at 350 psi.

It has been shown above that the amount of permanent gas formed depends on the raw material processed. Another important factor is set by locally prevailing economic conditions. It is possible to convert the byproduct gas to synthesis gas or hydrogen by reforming with steam, either alone or in conjunction with oxygen. A corresponding quantity of gas must therefore be withheld from the gas network. The extent to which hydrogen manufacture is based on straight coal gasification or on "Hy-gas" reforming depends on the economic balance between the sales value of the hydrocarbon gas and the higher cost of hydrogen produced from coal.

Shale Oil Gases

The nature of byproduct gases formed in the course of oil shale retorting depends primarily on the type of process employed. Externally heated retorts are capable of yielding a valuable make gas with a heating value ranging between 250 and 500 Btu/cu ft. Principal combustible component produced in this process is methane which is present in amounts between 20 and 50%. Some 5-10% ethylene and a like quantity of ethane round out the list of hydrocarbons in the make gas. Hydrogen sulfide content of these gases is relatively high, ranging around 1%.

American interest in oil shale processing methods is aimed principally toward direct-contact methods in which the heat required for distillation is carried to the shale by hot combustion gases. The resultant effluent gas is highly diluted with nitrogen and carbon dioxide and presents little attraction to the gas industry. A typical gas produced in the vertical cylindrical countercurrent retort of Union Oil Co. of California shows a gross heating value of only 188 Btu/cu ft, with a methane content of only 3.3%.[10] Other combustibles present include hydrogen (3.9%), carbon monoxide (11%) and ethane (1.7%). While this gas does not have a sufficiently high heat content per unit volume to permit its economic cross-country transmission, it is formed in such large amounts that it represents a formidable proportion of the entire thermal recovery. As much as 50% of the heating value of the shale oil may be contained in this low-grade byproduct gas. The best approach to its satisfactory exploitation is found in the production of power at the immediate shale distillation plant site.

Refining methods for shale oil take the routes of the petroleum or of the coal hydrogenation industry. Straight thermal cracking processes result in gasoline yields rarely exceeding 60 volume per cent while hydrogenation yields usually exceed 100 volume per cent (or about 80 weight per cent).

Byproduct gases formed during the hydrogenation of shale oil are quite similar to those described above in connection with coal hydrogenation. Cracking gases bear a fair resemblance to the gas make of mixed-phase petroleum cracking but are characterized by the presence of a comparatively large amount of carbon monoxide and by a high olefin ratio. Data reported to Egloff and co-workers[11] show a gas formation of 750 cu ft per bbl gasoline in residuum cracking of crude shale oil. Non-residuum cracking of the same oil yielded 1080 cu ft gas per bbl gasoline. Gas composition of the former type of operation is shown in *Table 7*.

Table 7. Composition in Residuum Cracking

CO_2, SO_2, H_2S, etc., %	0.4
CO	2.2
Hydrogen	3.4
Methane	26.4
Ethylene	6.8
Ethane	23.2
Propylene	12.0
Propane	12.4
Butene	1.8
Butane	6.0
Pentane	2.4
Misc. (O_2, N_2)	2.0

Inspection of these values shows that *shale oil refining* yields a byproduct gas at least equal in fuel value and quantity to that produced per bbl of gasoline manufactured from petroleum. The *primary shale oil extraction process*, on the other hand, promises a gas potential which is vastly inferior to the byproduct gases of petroleum production and refining or of coal hydrogenation and even to the mediocre tail gases of the Fischer-Tropsch process.

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Pilot plant shows adsorbent method ready for commercial application

A Safer Way To Stockpile NATURAL GAS

By C. V. SPANGLER

A new method for stock-piling natural gas is now ready for commercial application.

Exclusive

One of the most timely and completely new technological developments in the gas industry was demonstrated a few weeks ago at Warren, Pa. to a large number of gas utility engineers.

This preview performance revealed a pilot plant in operation for the storage of natural gas on "Methanite," a granular solid adsorbent material.

One of the chief features of the new process was pointed out as the relative safety achieved as compared with known hazards of storing natural gas as liquid methane.

The practicability of the process shown at Warren was developed by the Floridin Co. of that city, in conjunction with J. F. Pritchard & Co. of Kansas City, Mo.

The initial components of the pilot plant consisted of a gas compressor and pre-treatment equipment to remove substantially all moisture and condensable hydrocarbons from the natural gas entering the pilot plant. The clean gas, compressed to 500 psig, was then chilled and expanded in a second unit through several stages until about 15% of it was condensed to liquid methane. The balance was re-cycled.

A certain amount of condensable hydrocarbons were removed continuously from the process to be burned in a flare. No nitrogen binding problems were encountered. Apparently only traces of nitrogen were present. Incidentally, the natural gas used in the pilot plant was supplied from a line of The Manufacturers Light and Heat Co., the ultimate source being a northern Pennsylvania field.

The chilling of the gas was accomplished in a large "cold box." It was equipped with the required heat exchangers, expansion valves, and pertinent accessories.

The entire box was filled with ground cork insulation. Although not fireproof, the cork was found most satisfactory for the pilot plant application.

The third unit was a bed of Methanite, encased in a copper jacket. This bed contained about 2 cu ft or 63 lb of the granular adsorbent. It is interesting to note at this point that the 2 cu ft of adsorbent had the capacity to adsorb 630 cu ft of methane. This encased bed and its piping connections were insulated with block Foamglas. The whole assembly was encased in a heavy wall steel outer tank.

Fuller's earth, the raw material for the specifically prepared Methanite adsorbent, is found as a natural mineral of great reserve over a wide area in Florida and Georgia. Several hundred thousand tons of it are mined by open pit methods each year. The Floridin Co. is the oldest producer of this mineral, which is refined by the company for a wide variety of uses in the gas and oil industries.

It is inexpensive to produce and to prepare, as compared with similar other minerals, has every attribute for long service life when used as an adsorbent for natural gas. "Methanite" is the registered trademark of the Floridin Co. for its product—prepared specifically for gas storage.

The basic process flow used in the pilot plant for the adsorption and desorption of the gas would be closely followed in commercial scale plants. However, the refrigeration cycle would have to be modified to secure the most economical sequence.

In commercial application, a plant using Methanite as a gas storage adsorbent would introduce liquid methane directly on top of the adsorbent bed. Only enough liquid methane would be present to fill the piping. This would not

An impressive demonstration of the adsorption method of storing liquid methane: in the lower photo, two quarts of the liquid, spilled into a pilot flame, burn up violently in a few seconds; in the inset, a similar volume of methane on the granular solid adsorbent burns lazily for several hours.

An Ohio State graduate with long experience in subsidiaries of Columbia Gas System, Mr. Spangler has been with J. F. Pritchard & Co. for 10 years, now manages the Pittsburgh office of that firm.

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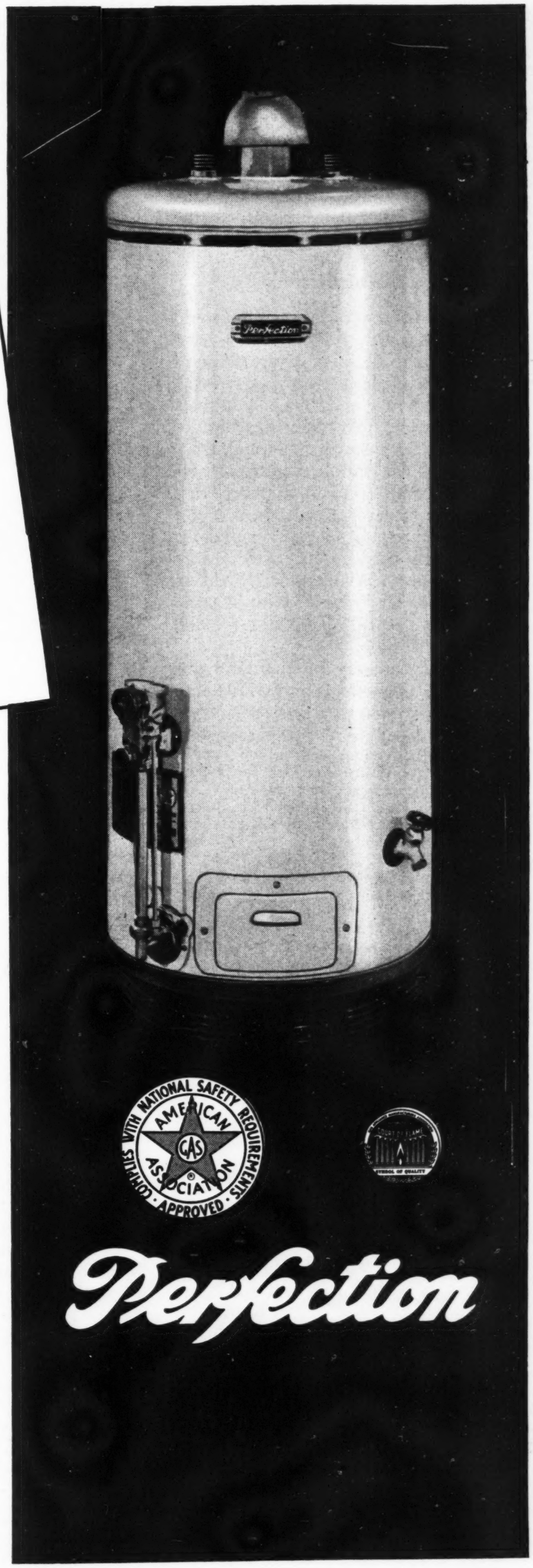

be enough to create any undue hazard.

The experimentation at the Warren pilot plant proved this to be an economical, effective, and practical way to accomplish the adsorption step. The liquid methane would be allowed to work down through the bed until adsorbed. Pilot plant studies with careful thermocouple analysis indicated excellent distribution of methane throughout the granular adsorbent bed.

Desorption

Desorption from the Methanite would be accomplished by circulating a warmer gas through the bed. The volume of gas circulated, and its temperature level, would be a matter of design to best meet each individual plant specification.

The warmer gas would supply the latent heat of desorption, and would release the stored gas. It is apparent that this system of desorption, although at a different temperature level, is analogous to the system used for reactivation in a natural gas adsorption type dehydration plant. Pilot plant operation at Warren proved gas desorption by this method was quite effective.

The total capacity of Methanite for the storage of methane is divided into three recognizable progressive stages:

1. *Physical Adsorption,* defined as the quantity adsorbed under equilibrium conditions at a pressure equal to the vapor pressure of the gas at the temperature of adsorption. Under this defined condition, 1 cu ft of Methanite adsorbs 156 standard cu ft of methane.
2. *Total Retention, Dry,* is defined as the quantity of vapor retained on the adsorbent under conditions where the entire pore space of the adsorptive material is filled with the adsorbed phase. But no liquid clings to the outer surface of the adsorbed particles.

   Under this defined condition, which includes *Physical Adsorption,* 1 cu ft of Methanite retains, "dry," 251 standard cu ft of methane.
3. *Total Retention, Soaked,* is defined as the total quantity retained under the definition Total Retention, Dry—plus the volume of gas equivalent to the amount of liquid required to wet the adsorbent particles.

   This defined condition represents the total retention capacity of the Methanite to store methane at its boiling point of —258°F. That capacity is 300 standard cu ft of methane on 1 cu ft of the granular adsorbent.

At this last defined condition—with Methanite being fully charged and "wet" with methane—the adsorbent does not contain any liquid which can flow should the Methanite be spilled out of a container and onto the ground.

The pilot plant operation proved that natural gas, as methane, when stored in the Methanite granular adsorbent at a temperature of —258°F, does not flow away as a liquid. It does release slowly as a gas when exposed to the atmosphere.

Methane can be released from it as a gas only as fast as the latent heat of desorption is transferred to it from its surroundings. The granular adsorbent greatly slows up this heat transfer if it is exposed as a pile, as it would be if it should be spilled out of a container onto the ground.

During the preview of the pilot plant, repeated demonstrations were given of the safety factors involved in the Methanite process.

Liquid methane in a quantity of 2 qts or 1½ lbs was released into a trough. It was easily ignited from a pilot fire. The methane would burn up in a violent flame in a few seconds. Its latent heat for gasification was picked up from its surroundings as it flowed, and from the radiance of its own flame.

The same quantity of methane, adsorbed by the Methanite, was then released into the trough. Similar conditions prevailed, except that a granular solid was spilled. The burning was much less on ignition and subsided to a small and longer-lasting fire.

Another test had the granular adsorbent, fully charged with methane, placed on fireproof insulation in a pile that was 8 in. wide and 4 in. high. This pile started to release vapor as it picked up latent heat for desorption from the air and the insulation.

On ignition, the first release of gas burned rapidly. However, the fire soon settled down to a lazy flame a few inches high. Gradually, over a period of at least an hour, the flame subsided and finally went out.

When the pile was stirred and new surfaces presented, gas again was released. The fire could be, and was, ignited a second time.

Such tests proved that Methanite had good insulation properties that prevented the latent heat needed for desorption from penetrating the pile at a rate sufficient to keep gas release and combustion going.[1]

There is every indication from the pilot plant experiments that a large pile —in a commercial application where a storage container might be broken— would burn off to a depth of only a few inches before extinguishing itself.

Among the engineers visiting the pilot plant demonstration the opinion was expressed that this new process would avoid the hazards attributed to liquid methane storage. They claimed that the Methanite method indicated its commercial adaption would entail no more hazzard than any normal gas plant operation.

Opinion was also voiced that the fire purposely generated with the charged Methanite could be quickly extinguished with conventional fire-fighting equipment. In fact, the test fire was actually smothered with both a blanket and a burlap sack. Some observers were mildly amazed to note that the charged Methanite at—260°F could actually be stirred with bare hands—without bad effect.

Another advantage for the Methanite method, as presented in the pilot plant demonstration, was the claim that in commercial plant construction for Methanite storage there would be less hazard and difficulty of construction than for liquid methane storage.

This is due largely to the physical differences in the stored materials which influence a different type and possibly a less expensive design for the solid material storage container. The square footage of ground area necessary would not materially increase.

Costs

The position of Methanite storage is now fairly clear in any comparison of the cost and effectiveness of available systems for natural gas peak load plants. It fits into these comparisons at about the same position as liquid methane storage. But, there is a very considerable difference in safety factor.

Preliminary estimates, subject to further review, place the probable cost of Methanite storage plants at about $20 to $22 per Mcf of installed storage capacity. This is for a completely installed plant of large size, such as multiples of 50 or 75 standard MMcf storage units. This estimate includes plant equipment for the storage of gas at a relatively slow rate, and regasification at a relatively rapid rate.

There are several variables to mention in this regard. One is the freight rate on the adsorbent from shipping point. Another is the handling cost of the adsorbent from the nearest rail siding —realizing a considerable tonnage is involved. Last is the variance in pipeline pressure available to the Methanite storage plant, plus the pressure against which the peak load gas must be delivered. A higher pressure on incoming gas is helpful—too high a pressure to deliver into is a penalty for the plant to work against.

In conclusion, the Methanite process was looked upon by many of the public utility representatives as a practical answer to the problem of securing approval from insurance organizations and public authorities for storage facilities of this type in populated areas. There was a lot of evidence at Warren to back up this supposition.

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[1]Although desorption of the small pile was extremely slow, desorption for purposes of regasification of the gas for sendout is rapid. Openings are provided in the container to circulate the warmer gases, which pass right through the granular adsorbent, as is done with solid type dehydration plants. Pressure drop and other data are well established. Part of the cycle will be removed continuously as product. Part will be recycled and in the cycle will have heat added to it continuously by condensing steam heaters, Petro-Chem direct contact heaters, or other means depending on individual plant specifications. If steam is used there is a possibility of freezing, so reversing type exchangers may be used. Or a regenerator-type exchanger can be employed, as is done in O_2 plants operated at similar temperature cycles.

Program for AGA Natural Gas Spring Meeting

Tulsa, May 8-9

GENERAL SESSIONS

Presiding: D. A. Hulcy
Vice President
American Gas Assn.

MONDAY, MAY 8, 10 A.M.

Welcome to Tulsa
George Stoner
Mayor of Tulsa

A Fuel With a Future
D. A. Hulcy

Our Research Program
E. F. Schmidt, chairman
Technical and Research Committee
Vice President, Lone Star Gas Co., Dallas

Regulation and Legislation Implications
Wesley E. Disney
Counsel, Independent Natural Gas Assn. of America

Closing Remarks
D. A. Hulcy

TUESDAY, MAY 9, 9:30 A.M.

The Gas Industry—Today and Tomorrow
H. A. Cuthrell, President
American Gas Assn.

Natural Gas Reserves for the Future
N. C. McGowen, Chairman
AGA Committee on Natural Gas Reserves
President, United Gas Pipe Line Co., Shreveport

The Relation Between Higher Operating Costs and Rates
1. The Problem of Increased Costs
(Speaker to be Selected)

D. A. Hulcy
. . . it's his show

2. Their Effect on Operations
Guy T. Henry, President
Central Indiana Gas Co., Muncie
3. How Can Rates Help in a Solution
W. T. Herrman
Commonwealth Services Inc., New York

"The Toughest Inch"
Motion picture sponsored by Columbia Gas System, New York
Introduced by Oliver S. Hagerman, President, United Fuel Gas Co., Charleston, W. Va.

Closing Remarks
D. A. Hulcy

TRANSMISSION COMMITTEE

Open Meeting

Presiding: F. A. Hough
Chairman,
Transmission Committee

MONDAY, MAY 8, 2 P.M.

Transmission-Line Type Storage—Capacity Calculations and Cost
W. C. Mosteller, Assistant to Vice President
Southern Counties Gas Co.

New Data on Use of Solid Desiccants
E. Paul Wilkinson (Speaker)
Magnolia Petroleum Co., Dallas
Boris Sterk (Co-author)
Socony-Vacuum Oil Co., Brooklyn

Trace Removals of Sulphur Compounds From Natural Gas
J. L. Oberseider
Southern California Gas Co., Los Angeles

Recent Gas Turbine Installations in Europe
Kurt Niehus, Asst. Technical Director
Brown Bovari Corp., New York

"Pipeline Construction in Rough Terrain"
Motion picture sponsored by H. C. Price Co., Bartlesville, Okla.

PRODUCTION-CHEMICAL

31 events on program for May 22-24 meeting

With the science of gas production continuing to make the giant strides that have characterized the post-war period, tremendous industry interest is centering this month in a meeting to be held at the Hotel New Yorker in New York City.

The occasion is the annual AGA Production and Chemical Conference, and the time set is May 22-24.

No less than 31 events are on the program, and of these several are symposia embracing four or more presentations.

Chemical committee and production committee chairmen G. V. McGurl, Koppers Co., Pittsburgh, and J. P. Stephens, Cincinnati Gas & Electric Co., have arranged an intensive selection of papers and discussions by top experts. Representative of the fare offered are these:

"Symposium: Reforming Hydrocarbon Gases," with J. L. Turnan of Worcester Gas Light Co. as moderator.

"Complete Replacement of Natural Gas Sendout," by F. D. Howell, Dominion Natural Gas Co., Brantford, Ont., Canada.

"Controlled Gas Mixing," by R. B. Paquette, Peoples Gas, Chicago.

"New Developments in Odorants," by E. E. Johnson, California Research Corp., Richmond, Calif.

Gilbert V. McGurl
. . . presides at chemical meet

The conference will get under way Monday morning with two general sessions, followed by parallel sessions of the chemical group and production men Tuesday morning, May 23. Upon conclusion of these gatherings, luncheon conferences will be held, with the subjects of "Carbonization and Coke," "High-Btu Gas," "Oxygen and Its Application to Gas Making," and "Plant Waste Disposal" topics for discussion.

Wednesday morning will witness another general session, followed by additional luncheon conferences, at which time "Chemistry in the Gas Industry," "LP-Gas," and "Water Gas" will be featured subjects.

Mr. McGurl and Mr. Stephens will preside.

Arnold Heads Flordia-Georgia

John L. Arnold, general superintendent of the Albany (Ga.) Gas Dept., was installed as 1950-51 president of the Florida-Georgia Gas Assn. at the organization's 15th annual meeting held April 20-22 at the Biltmore hotel in Palm Beach, Fla.

Upon retiring from the presidency, J. K. Roberts, Florida Public Utilities Co., West Palm Beach, automatically became vice president. Jack W. Owen, Central Florida Gas Corp., Winter Haven, was re-elected secretary-treasurer. Eleven directors were named.

GAS AND THE ECONOMY

South's expansion a challenge, SGA told

The rapidly expanding economy of the South and the Southwest and the opportunity and obligation of the gas industry to stand behind and foster this expansion were central themes as the Southern Gas Assn. met for its 42nd annual convention in Galveston, Texas, March 27-29.

Adding emphasis to expansion of the industry in that part of the country, it was announced that a record total of 1153 had registered, about 200 more than a year ago.

Tuesday morning's general session was sparked by a fighting talk by L. L. Baxter of Arkansas Western Gas Co., president of the association, in which he urged a vigorous program with architects and builders to combat electric efforts to raise barriers against gas in new homes.

An iconoclastic banker-professor, Dr. Arthur A. Smith, added zest with his challenging remarks later in the morning.

On the subject of Communism and the necessity for business to fight divide-and-rule efforts against it, the audience applauded Dr. Smith, who is chairman of the Department of Economics, Southern Methodist University.

However, C. H. Zachary, president of Southern Union Gas Co., Dallas, at the final luncheon was compelled to answer once and for all Dr. Smith's assertions about the cost of electric vs. gas refrigerators. Using Dr. Smith's own figures, he pointed out that if Dr. Smith had bought a gas instead of an electric refrigerator in 1938, his gas refrigerator would still be in good working order, and would have saved him enough money to buy a range in 1949, too. The exhortation by Hugh Cuthrell, president of the American Gas Assn., to "get into merchandising, directly or indirectly, because it's along that high and exciting road that a successful future for the gas industry lies . . ."

Vast opportunities unfolded in the talk of W. Paul Jones, president of Servel Inc., who declared it should be possible to sell annually at least half a million more gas refrigerators than ever before . . .

The vital employee relations sessions, and the talk on this subject by Merlyn S. Pitzele, member of the New York State Board of Mediation, who declared that "control of the labor force in natural gas offers some very attractive rewards to the union," but that the opportunity for employers to improve their employee relations is great now because "no important economic issues" are expected to come up in this field in the near future . . .

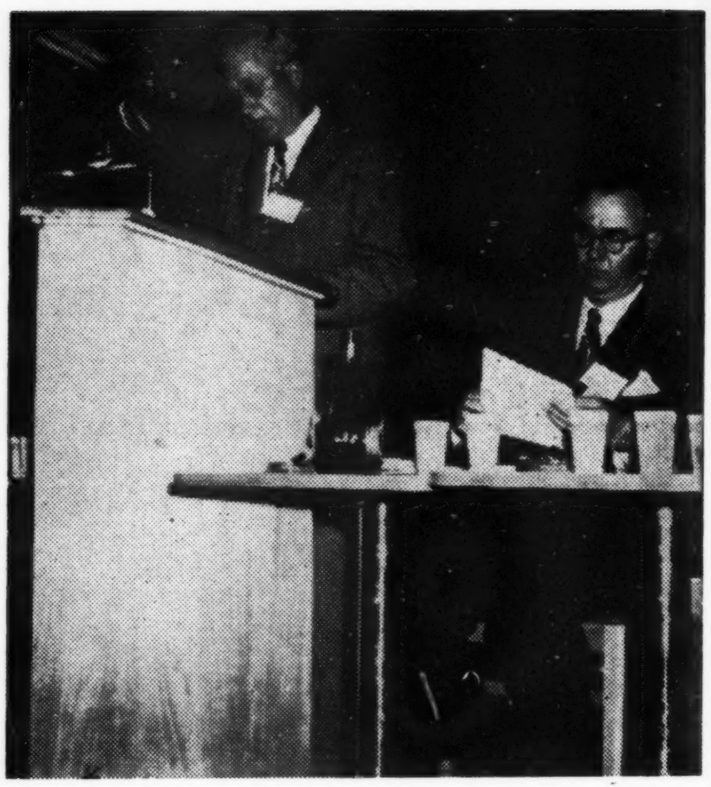
Announcement by President Baxter that there had been a 50% increase in attendance at the association's conferences on accounting, employee relations, operating and sales . . .

The following new officers of the association were elected for the coming year:

Carl H. Horne, Alabama Gas Corp., Birmingham, president; L. L. Dyer, Lone Star Gas Co., Dallas, first vice president; and J. H. Wimberly, Houston Natural Gas Corp., second vice president.

Officers continuing in office are H. T. McConkey, Southern Union Gas Co., Dallas, treasurer; E. T. Anderson, Atlanta Gas Light Co., secretary; and R. R. Suttle, of Dallas, managing director.

H. K. Griffin, Mississippi Gas Co., Meridian, was reelected a director. New directors elected were Charles S. Coates, Tennessee Gas Transmission Co.; A. B. Parker, Hardwick Stove Co., Houston; and J. H. Collins Sr. of New Orleans.



ABOVE: New Southern Gas Assn. officers are (from left) H. V. McConkey, Dallas; J. H. Wimberly, Houston; Carl H. Horne, Birmingham; E. T. Anderson, Atlanta; L. L. Dyer, Dallas.

AT RIGHT: Hugh Cuthrell, Brooklyn, urges Southerners to "get into merchandising"; Outgoing President L. L. Baxter, Fayetteville, Ark., checks notes.

PEPPING UP SALES

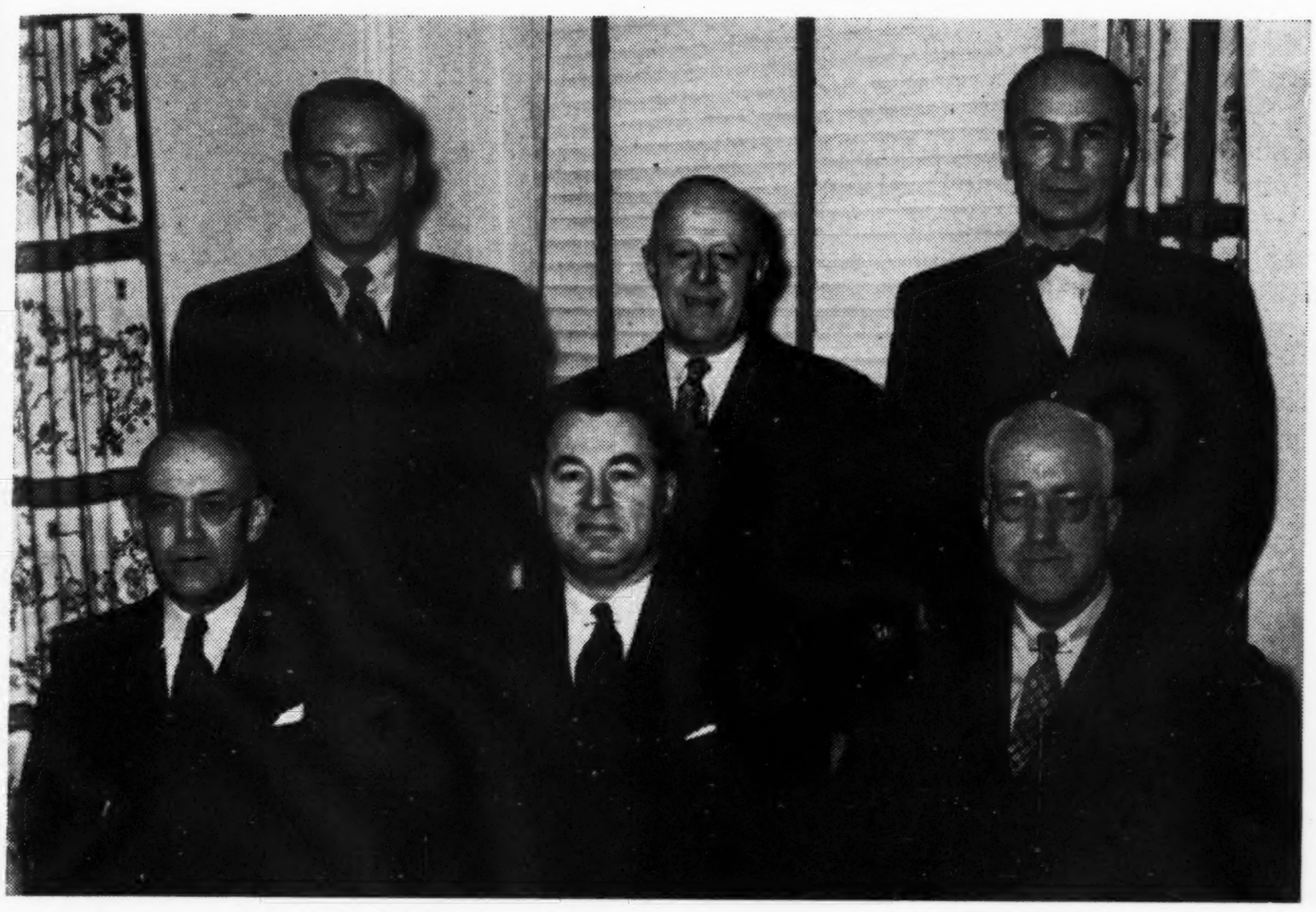
Electric threat eyed at regional meetings

Gas salesmen of two regions—midwest and eastern—are back on the job this month, with the two areas' spring regional sales conferences behind them. Eastern Natural Gas Regional Sales Council held its annual meeting in Pittsburgh, Pa., April 17-18. Midwest salesmen met in Chicago, March 27-29.

Electric competition was a major topic at the midwest meeting, and Julius Klein, vice president of Caloric Stove Corp., told conference delegates that the tremendous merchandising and advertising expenditures of the electric appliance industry must be met fully if gas range cooking is to continue its growth. Coordinated promotional and advertising efforts by the gas industry reversed an alarming sales trend in the latter part of 1949, Mr. Klein pointed out, but warned that gas salesmen face a tougher job in combatting the tremendous electric cooking promotional programs. Thirty-eight thousand salesmen were trained by electric appliance manufacturing companies in 1949. The gas industry total for the same period: 2150.

Among other speakers who addressed the midwest group were Ray J. Vandagriff, Laclede Gas Co. (St. Louis); H. D. Valentine, Peoples Gas Light & Coke Co. (Chicago); James F. Oates, Peoples Gas Light; Russell M. Perkins, Windsor (Canada) Gas Co.; W. Paul Jones, president, Servel Inc.; N. D. Jennings, AGA; Irene Muntz, home service director, Rochester (N.Y.) Gas & Electric Corp. and chairman of AGA's home service committee; A. von Wening, vice president, A. O. Smith Corp.; John J. Bourke, director of commercial cooking, AGA; F. X. Mettenet, vice president, Peoples Gas Light.

James E. Humphreys (Ohio Fuel Gas Co.) was chairman of the eastern council's conference, which was held in Pittsburgh's Hotel William Penn. Speakers and demonstrators during the two-day confab were Albert E. Conover, president, Equitable Gas Co. (Pittsburgh); Harold Massey, GAMA assistant managing director; Eleanor Marvin, Manufacturers Light & Heat Co.; Sol Weil, eastern manager, Geo. D. Roper Corp.; George L. Scofield, Republic Light, Heat & Power Co. (Buffalo); W. Paul Jones, Servel; Frank A. McFerran, Ruud Manufacturing Co.; H. D. Valentine, Peoples Gas Light; John A. Gilbreath, Servel; Clifford E. Hall, AGA promotion bureau; F. B. Jones, Equitable; Frank A. Williams, AGA residential gas section secretary; James E. West, Washington (D.C.) Gas Light Co.; and Thomas M. Joyce, general counsel of Massachusetts Electric & Gas Assn. (Boston).



New England Gas Assn. officers for 1950-51 gather around their outgoing president, E. H. Eacker of Boston, at the annual March meeting. Front row, from left: John A. Hiller, Portland, Maine, new president; Mr. Eacker; G. G. Howie, Cambridge, Mass., first vice president. In back row are S. R. Knapp, Hartford, Conn., second vice president; Otto Price, Boston, treasurer; Clark Belden, clerk.

REVIVAL IN NORTHEAST

Industury reawakening with natural gas seen

Natural gas—the opportunities it presents for expansion and the new plans it necessitates—dominated the speeches and thinking of more than 600 who attended the annual business conference of the New England Gas Assn. at the Hotel Statler, Boston, March 23 and 24.

Speaking from a wealth of experience, D. A. Hulcy, first vice president of the AGA, made the following points, in connection with the expected arrival of the "ideal fuel" in New England:

1. The 30 years' known supply of natural gas reserves at current rates of use gives an excellent backlog and compares favorably with other commodities—for instance, the 15 years' reserves of crude oil and 19 years' of copper.

2. Natural gas, while possessing many advantages, should not be regarded as a cure-all for problems of rates, etc.

3. The house heating field should be a good one in New England with its rigorous climate, but the load situation needs careful study to determine how much house heating is economically feasible in the area.

The fact that natural gas, although it has not arrived, has stimulated industry in New England already was brought out when Clark Belden, executive secretary, announced a 35% growth in association membership, much of it attributable to the desire to attend sessions where one can learn about the new fuel.

"We're on the threshold of developments of great promise," predicted S. H. Hobson, president of GAMA.

As an example of what coordinated sales effort will do, Mr. Hobson mentioned the comparatively recent efforts of eight manufacturers of gas incinerators. One example, he said, was purchase of 9000 incinerators in one town in the Middle West, the incinerators having been merchandised to the town.

With major pipeline companies drawing a bee on the New England area, Mr. Hobson continued, good house heating business is expected.

Those attending got some down-to-earth advice about natural gas from Robert E. Ginna, vice president of Rochester (N. Y.) Gas & Electric Corp., a company that has had a wealth of experience in this field.

Mr. Ginna concluded:

"Whether 1950 is the end of a half century or the beginning of a new one, New England, gas-wise, is on the brink of a new era. And I use the word 'brink' advisedly, for a misstep now can mean immeasurable damage and almost irreparable harm. Therefore I say to you, be rate-wise and public relations-wise and 'enrich' yourselves with natural gas."

The following 1950-51 officers and directors were elected:

President, John A. Hiller, Portland Gas & Coke Co.; first vice president, Gordon G. Howie, Cambridge Gas Light Co.; second vice president, Sherman R. Knapp, The Connecticut Light & Power Co., Hartford; treasurer, Otto Price, Boston Consolidated Gas Co.; executive secretary (clerk), Clark Belden.

Elective Directors: Peter A. Anderson, Portland; Harold E. Ayer, Lynn, Mass.; John J. Dowling, New London, Conn.; Fred H. Faulstich, Springfield, Mass.; Jesse L. Johnson, Providence, R. I.; Ronald A. Malony, Bridgeport, Conn.; S. C. McLaughlin, Claremont, N. H.; H. Coleman Moore Jr., Cambridge, Mass.; Herbert A. Murphy, Boston; Charles R. Prichard Jr., Nashua, N. H.; John J. Quinn, Boston; Charles E. Rainsbury, Boston; William Webster, Boston; John West, Worcester, Mass.; Alexander McW. Wolfe, Boston; R. B. Wright, Boston; Roy E. Wright, Cambridge.

CALENDAR

MAY

AGA Commercial Gas School—Hotel Gibson, Cincinnati, May 1-5.

Oklahoma Utilities Assn. Annual Convention — Biltmore hotel, Oklahoma City, May 4-5.

AGA Natural Gas Department Spring Meeting—Mayo hotel, Tulsa, May 8-9.

Liquefied Petroleum Gas Assn. Convention & Trade Show—Palmer House, Chicago, May 8-11.

American Foundrymen's Assn.—Cleveland, Ohio, May 8-12.

AGA Executive Conference — The Broadmoor, Colorado Springs, May 11-12.

Pennsylvania Gas Assn.—Galen Hall, Wernersville, Pa., May 16-18.

AGA Gas Production and Chemical Conference—Hotel New Yorker, New York, May 22-24.

National Restaurant Assn.—Navy Pier, Chicago, May 23-26.

The Natural Gas and Petroleum Assn. of Canada—Prince Edward hotel, Windsor, Ont., May 25-26.

Gas Appliance Manufacturers Assn. Annual Meeting—The Greenbrier, White Sulphur Springs, W. Va., May 28-30.

Short Course in Gas Technology—Texas College of Arts & Industries, Kingsville, May 29-31.

JUNE

The American Society of Refrigerating Engineers 37th Spring Meeting—Muehlebach hotel, Kansas City, Mo., June 4-7.

Edison Electric Institute Annual Convention—Atlantic City, June 6-8.

Michigan Gas Assn. Annual Convention — Grand hotel, Mackinac Island, Mich., June 19-20.

New York-New Jersey Regional Gas Sales Conference—Essex & Sussex hotel, Spring Lake, N. J., June 19-20.

Canadian Gas Assn. Annual Convention—Manoir Richelieu hotel, Murray Bay, Quebec, June 19-24.

AUGUST

Pacific Coast Gas Assn. 57th Convention—Seattle, week of Aug. 1.

SEPTEMBER

New Jersey Gas Assn. Annual Convention—Monmouth hotel, Spring Lake, N. J., Sept. 8.

National Petroleum Assn.—Hotel Traymore, Atlantic City, Sept. 13-15.

Mid-West Gas Assn. 27th Gas School & Conference — Iowa State College, Ames, Sept. 14-15.

OCTOBER

AGA Annual Convention and GAMA Exhibition of Gas Appliances and Equipment—Atlantic City, N. J., Oct. 2-6.

Texas Mid-Continent Oil & Gas Assn. Convention—Dallas, Oct. 4-5.

National Safety Congress & Exposition—Chicago, Oct. 16-20.

National Metal Exposition—Amphitheatre, Chicago, Oct. 23-27.

NOVEMBER

American Petroleum Institute Annual Meeting—Los Angeles, Calif., Nov. 13-16.

DECEMBER

The American Society of Refrigerating Engineers—Hotel Commodore, New York, Dec. 3-6.

1000 Attend Record-Breaking Measurement Short Course

Hailed by several speakers as the largest school of its kind in the world, the 25th Southwestern Gas Measurement Short Course held at Norman, Okla., April 11-13, paused at its opening session to observe its silver anniversary. Nearly 1000 executives, engineers, and employees of gas and oil companies from 26 states of the Union and Canada and Mexico witnessed the presentation to W. H. Carson, dean of the school of engineering, University of Oklahoma, and chairman of the executive committee of the course, of a silver-plated plaque and a scroll naming him the one man most responsible for the "tremendous success" of the short course, as well as gifts.

Principal general assembly speaker was Joseph H. Russell, vice president, Gulf Oil Corp. and Gulf Refining Co., Houston. Declaring that gas production, transmission, and distribution is now one of the miracle industries of the world, Mr. Russell added:

"I can understand the growth of the gas industry better by figuring that the revenue from gas for the United States last year amounted to about $10 for every man, woman, and child in this country."

The situation imposes upon the American oil and gas industry the obligation to exercise a brand of leadership "commensurate with the importance of the industry," the speaker said.

W. H. Woods, Gulf Oil Corp., chairman of the general committee for the 1950 course, was succeeded by Ben F. Worley, United Gas Corp., Shreveport. Other committee chairmen elected at the close of the school included James L. Griffin, Northern Natural Gas Co., Omaha, program committee; T. S. Whitis, West Texas Gas Co., Lubbock, Texas, publication; W. A. Brewster, Arkansas Louisiana Gas Co., Shreveport, practical methods; K. R. Tibbetts, Warren Petroleum Co., Tulsa, exhibits; W. H. Carson, local arrangements; Miss Kate A. Niblack, secretary, Oklahoma Utilities Assn., Oklahoma City, publicity.

Thirty equipment manufacturers had educational exhibits on the floor of the drill hall on North Campus where the sessions of the school were held. A number of the instructors were chosen from among these exhibitors.

Special Sessions Emphasized On Appliance Course Program

An increased emphasis is being placed this year on specialized sessions when the Gas Appliances Short Course convenes May 31-June 2 at the University of Tulsa, Tulsa, Okla.

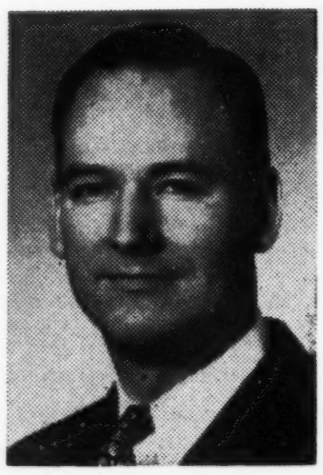
The course, sponsored by the Southern Gas Assn., will be offered by the College of Petroleum Sciences and Engineering.

Subjects to be included in the general sections will be addresses on "What's New in the Future of the Gas Industry" and "It's Your Industry," speakers to be announced later. A general gas film and one titled "A Pipeline Licks the Weather" will be shown.

Natural gas technical subjects will include: Gas Fundamentals, Why Gas is Best for Cooking, Correct Tools and Their Uses, Location of Gas Leaks, Importance of Correct Pipe Sizing, Appliances and Service Regulation, Gas House Heating, Gas Refrigeration, Servicing of Water Heaters and Gas Ranges, and Automatic Controls.

Space will not permit display of equipment other than cut-away models or instructional material.

Personnel Men Elect Christell



E. W. Christell

New chairman of the AGA Great Lakes Personnel Conference for the coming year is Elmer W. Christell, superintendent of the employee relations department, Peoples Gas Light & Coke Co., Chicago, who was elected at the Chicago meeting of the conference March 12.

Serving with Mr. Christell are Norman D. Bradley, East Ohio Gas Co., Cleveland, vice chairman, and Hugh F. Foster, Consumers Power Co., Jackson, Mich., secretary.

How Wisconsin Power & Light Co., Madison, carries on its employee information program was detailed at the meeting by W. D. Baker, personnel director for the company.

Next conference meeting has been billed for June 16 in Chicago.

Keeps Your Furnace "in Tune with the Weather"

New GASAPACK

MULTI-STAGE Flame Control

(Single-Contact Thermostat)

It's revolutionary... this new MULTI-STAGE flame control feature of the GASAPACK! Adds a new principle of automatic heating to your furnace that assures steadier room temperatures never before possible... A modern development in true comfort, fuel economy — at a saving in control cost, assembly time, field installation expense.

Find out TODAY how the new GASAPACK will add extra selling force, extra satisfaction to your new furnaces. Write for details and samples.

New GASAPACK Model 54

A single basic unit with Heat-Anticipating Thermostat and Transformer. Avoids need for separate solenoid, main valve, pressure regulator, A-cock, B-cock and other units. A.G.A. Listed. 100% Fail Safe. Capacity: 70,000 or 100,800 B.T.U. on gases less than or more than 800 B.T.U. per cu. ft.

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FOR HEATING . . . AIR CONDITIONING . . . REFRIGERATION

TM *Tested and Approved*

300,000 TM thermostats now in use—many for three heating seasons—have demonstrated the comfort advantages of the Honeywell **TM** principle. Home owners are enjoying a new standard of heating comfort —made possible by Honeywell scientific research .

TM *Meters the Heat*

Controlled frequency of burner operation provides an even flow of heat under all conditions. Thermostat Magic means more than thermostat accuracy —it means maximum heating comfort and efficiency— at no increase in heating cost.

TM *Thermostat Magic means:*

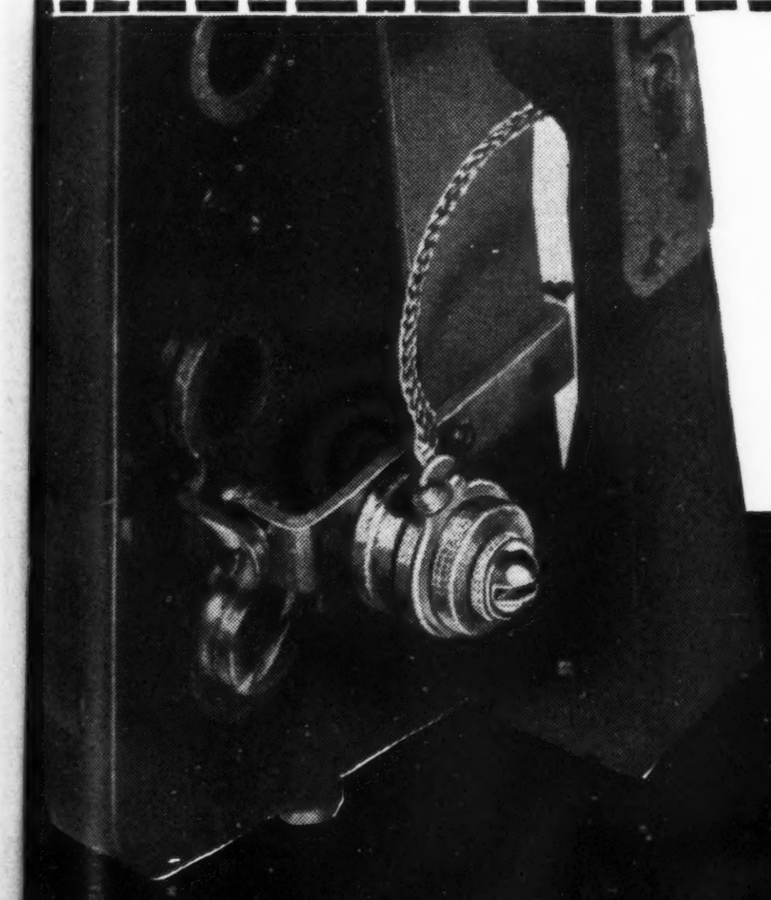
No More Waiting for Heat

No More Chilly Floors

No More Overheating

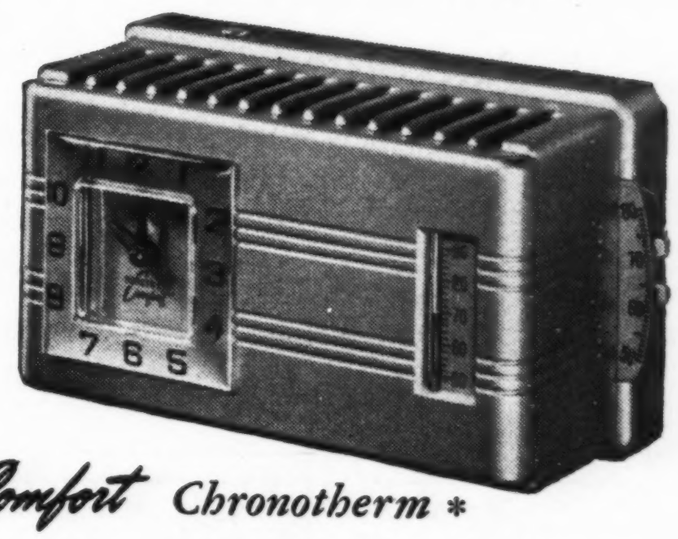
No More Fuel Used — instead

More Comfort For Your Heating Dollar



The heating element

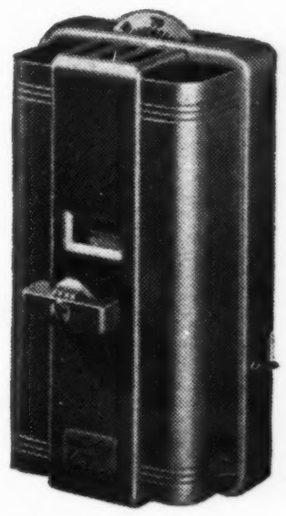
TM means *Thermostat Magic at no increase in heating cost!*



TM *Comfort Chronotherm* *

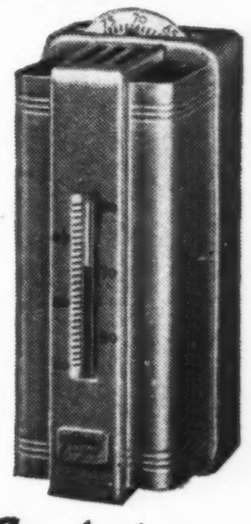
The well-known electric clock thermostat—automatically provides lowered night temperatures and morning pick-up. NOW better than ever with the Thermostat Magic of **TM**.

**Available in a few weeks.*



TM *Comfort Time-O-Stat*

For lowered night temperatures. Set the dial for the morning pick up time you select—wake up in a comfortably warm house. The Time-O-Stat now assures pin point control through the Thermostat Magic of **TM**.



TM *Comfort Acratherm*

The finest thermostat of its type in the world. Featuring the easy-to-read dial adjustment, precision control—and NOW, Thermostat Magic with Honeywell **TM**.

TM keeps the heat coming in regulated portions

TM furnishes the required heat by properly regulating the length of burner operations in accordance with outside weather conditions—longer in cold and shorter in mild weather. Comfort always!

Long and irregular burner operations permit up and down temperatures—allow rooms to get too hot or too cold for comfort. The varying temperatures cause sensations of drafts and chills. Discomfort!

MINNEAPOLIS

Honeywell

FIRST IN CONTROLS

REGULATION

UNIFORM SCHEDULES

Court refuses review of FPC rate order

A court of appeals of the United States last month refused to review the FPC order requiring interstate pipeline companies to file uniform rate schedules.

The test case, brought forward by United Gas Pipe Line Co., Shreveport, and Michigan Consolidated Gas Co., Detroit, was dismissed by the court on grounds that it could not review the order under its statutory authority because the FPC did not hold a quasi-judicial hearing and take evidence before issuing the order.

As an alternative, the court suggested that the companies could take the matter into federal district court through an injunction proceeding.

United Gas contended that contractual changes which would prove detrimental to its interests would result from compliance with the order. Michigan Consolidated said it feared its supplier, Panhandle Eastern, might use the new rate schedule to make changes which would have a similar effect.

The commission declared that more than half the interstate pipeline companies had already filed their new tariff schedules under the terms of the order.

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FOR

SPRAGUE No. 1-A	IRONCLAD No. 1	ALSO:
SPRAGUE No. 1-D	TOBEY No. 1	ALL-LEATHER
SPRAGUE No. 2	Iron	DIAPHRAGMS for
SPRAGUE No. 3	Gas	TOBEY-A and
SPRAGUE No. 5	Meters	IRONCLAD No. 2

We have specialized in Metal Rim Diaphragm manufacturing, under the best engineering skill, for twenty-odd years.

Records definitely show the superior advantage of these diaphragms over all others, and this should give you that feeling of confidence which only years in service can produce.

Reasons Why—

METAL RIM DIAPHRAGMS

Measure Gas Accurately:—

- NO WETTING
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Plus—

Our LMPCO oil which stays in the leather easily through a 10-year period.

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Florida Commission Reaffirms Rate Cut For Jacksonville

The Florida State Utilities Commission refused March 29 to change its order cutting rates of the Jacksonville Gas Co. and directing refunds of more than $150,000 to customers.

Reaffirming a directive of Dec. 2, the railroad and public utilities commission ordered the reduced rates into effect by April 1.

However, the company will have until July 1 to discontinue its flat rate charges and change unmetered service to metered service.

The reduced rates were made retroactive to Jan. 1, 1949.

The City of Jacksonville had set reduced rates for the company effective Jan. 1, 1949, but the company appealed to the state agency.

A special law of 1921 gives the state commission jurisdiction over disputes between the city and the company. It has no power to fix gas rates anywhere else in the state.

The company announced plans to appeal.

Pacific Lighting Pipelines Now Under Subsidiary

A new subsidiary of Pacific Lighting Corp., San Francisco, named Pacific Lighting Gas Supply Co., a Nevada corporation, has filed articles of incorporation to do business in California. Pacific Lighting Gas Supply is a reincarnation of the long defunct Industrial Fuel Supply Co.

With some of the same officers as its parent company, including Robert W. Miller as president, Robert Hornby as vice president, and Leroy Edwards as vice president and general manager, the company was set up to take over the pipeline activities of Pacific Lighting Corp. The latter, however, will maintain its position as principal stockholder for Southern Counties and Southern California Gas Co.'s.

The move was made as a result of the FPC's having invaded the sphere of state utility regulation in the East Ohio Gas Co. case. A similar extension of jurisdiction over the financial dealings of SoCal and So-Counties would nonetheless leave Pacific Lighting Gas Supply free of regulation.

Kerr Bill Dies

As *GAS* went to press, the Kerr bill to exempt independent producers of natural gas from FPC jurisdiction was moribund.

The only spark of life remaining was the faint flicker of a hope that Congress might muster up enough votes to override President Truman's veto. This, it appeared, would take some doing.

Odyssey of the bill, in brief:

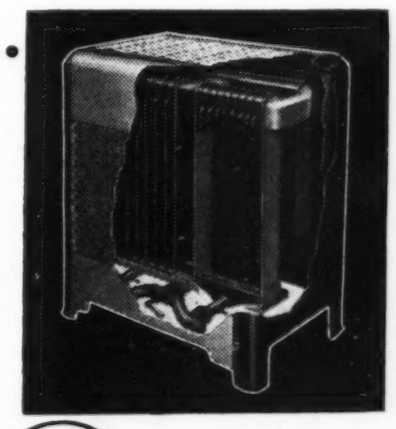
March 29: By the hardly comfortable margin of 44-38, the Senate passed the bill and sent it along to the House.

March 31: It squeaked through the House by 176-174.

April 15: The President signed its death warrant.

THE NEW ROYALINE CIRCULATORS are designed for *three-way customer appeal* . . . they are outstanding in appearance, comfort and economy! Styled with smooth, flowing lines and finished in a beautiful duo-tone brown enamel, a Royaline Circulator will add charm to any surroundings. The famous Humphrey burner and ingenious method of rapid heat exchange and circulation assure clean, fast and sustained heat . . . the initial low cost and economical operation, plus years of satisfactory performance, will appeal to any customer.

Write today for catalog and prices on Humphrey Royaline circulating gas heaters.



FEATURES THAT WILL MAKE ROYALINE YOUR PROFIT LINE!

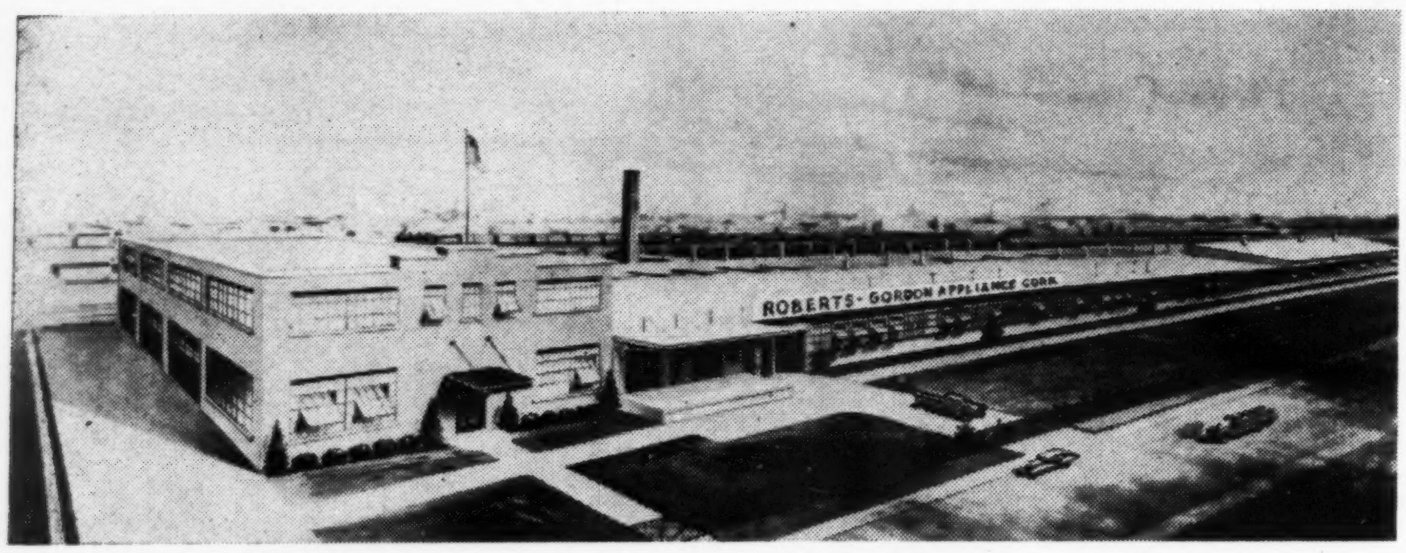
ROYALINE circulating heaters are sturdy all metal construction, built to last a lifetime, beautifully styled and finished in popular, easy to clean, rich duo-tone brown.

The heavy gauge steel heat exchanger effects a rapid transfer of heat to the air stream through the large top and front grille area, and at a minimum of fuel cost. The famous Humphrey Economy Burner can be controlled either automatically or manually . . . completely equipped with latest safety controls. Operate on all types of gases.

GENERAL GAS LIGHT COMPANY

KALAMAZOO MICHIGAN

23 Warren Street, New York City • 2nd Unit Santa Fe Building, Dallas • 225 Eleventh Street, San Francisco



Roberts-Gordon Appliance Corp., manufacturer of conversion burners, recently dedicated this new building in Buffalo. Containing 60,000 sq ft of working space, the plant will permit accelerated production of industrial burners, air conditioners, heaters, boilers, and furnaces, as well as conversion burners.

SPECIALIZED Fittings for your COPPER TUBE SERVICE RENEWALS

AT THE MAIN, get your copper service renewals off to a good start with a Dresser Street Tee. Specially designed for use with copper tubing. Safe, quickly installed, permanent. Also available in insulating types.

AT THE CURB COCK, connections are made simply and quickly with Dresser Male Adaptors. One adaptor on each side permits use of existing cock.

INSIDE THE BASEMENT, the Dresser Service Head Adaptor quickly makes up gas-tight on the copper tube, seals off the space between the copper and the old steel service, provides a rigid connection for basement piping.

Fittings illustrated are part of a *complete line* of service fittings designed by Dresser especially for copper tube renewals. *Write today*—ask for sales engineer to call and explain how others are using copper tubing.

DRESSER "COPR-TUBE" FITTINGS

Dresser Manufacturing Division (One of the Dresser Industries), 59 Fisher Ave., Bradford, Pa. In Texas: 1121 Rothwell Street, Houston • In Canada: Dresser Manufacturing Co., Ltd., Toronto, Ont. • Sales Offices: New York, Chicago, Houston, San Francisco

FINANCIAL

Natural Gas Business Near $1 Billion in 1949

Natural gas companies did almost a billion dollars worth of business in 1949.

Recently released by the FPC, a study of operating revenues and income for December 1949 and for the 12 months' period showed that in the latter capacity, companies reported $985 million worth of business. For the month, they racked up $107 million. These two figures represented gains over 1948 by 11.8% and 13% respectively.

Operating income showed fairly similar trends. For December, the totals were up a sizzling 22.7%, to $23.7 million. For the year, the figure was much more modest—5.1% increase, to $171.2 million.

Gas sales jumped 9.8% to 161,788 MMcf for the month. Residential sales were up 13.3%, commercial rose 9.6%, and industrial went up 10.7%.

Net gas utility plant aggregated $2.52 billion—up from last year's $2.14.

Eighty-three companies were covered in the report.

Ohio Fuel's Higher Wholesale Rates Go Into Effect

Ohio Fuel Gas Co.'s (Columbus) new, higher wholesale rates for gas went into effect April 1.

Amounting to $726,331 annually based on a 12-month period ending Sept. 30, 1949, the increases became effective on a technicality. Suspended in August 1949 by FPC pending hearings, the rates would have automatically become effective Feb. 6, 1950, under a provision of the Natural Gas Act limiting rate suspension to five months.

Subsequently, the filing of a motion to put the rates into effect was postponed until April 1.

However, Ohio Fuel was required to post $100,000 bond and keep close accounts of the added revenues in view of possible later refunds—at 6% interest.

Twenty-three cities are affected.

Appliance Shipments Hit Peaks

GAMA has taken a long look back into the past—14 years, to be specific—and has come forth with comparative figures on automatic gas-fired water heater shipments which show an impressive growth in usage of this equipment.

Beginning in 1936 with shipments of 269,000, progressing through 1940's 551,000, the pre-war peak of 800,000, the forced decline to less than 300,000 in 1943, and the pickup as the war ended, total movements jumped past the million mark in 1946 (the first full postwar year) and have remained there steadily since.

In 1946, shipments hit 1,319,000; in 1947, *the* year, 1,800,000; in 1948, 1,500,000; and in 1949, when the Court of Flame program pulled sales out of the mire of a bad start, 1,466,000.

Builds Volume Faster

BECAUSE IT OFFERS

Better Performance AND Bigger Value

5500 Series
Shown 5508-2

Advertised in

LADIES HOME JOURNAL

•

BETTER HOMES AND GARDENS

Advertisements in May and June in both magazines. Write for tie-in mats and other dealer helps.

Check the performance of this or any other Hardwick Range — Then check the price tag. You'll find why Hardwick is helping so many alert dealers to build volume faster. Hardwick outbakes other ranges in far higher price brackets. It's beautiful. It's sturdy. Write for full details on the fast-selling, profit-building Hardwick line.

HARDWICK GAS RANGES

HARDWICK STOVE COMPANY • CLEVELAND, TENNESSEE

Gas Sales Hit New Peaks

The pattern of gas sales in February extended the long-familiar pattern of increase, the AGA has reported.

Up 16.1% over February, 1949, sendout hit 4.08 billion therms. For the 12 months ended Feb. 28, the total was 36.3 billion, 10.1 better than the previous year's showing.

Natural gas continued to carry the load, registering a 18.1% rise, while manufactured gas was sliding and mixed gas continued its long downward trend.

Financial newsnotes

Extension of interim rates charged by Long Island Lighting Co., Mineola, Borough Gas Co., Brooklyn, and Brooklyn Union Gas Co., and Kings County Lighting Co., all serving the Brooklyn-Long Island area, was approved by the New York Public Service Commission late in March. All were scheduled to expire March 31. . . In Madison, Wis., the state public service commission approved an increase in charges of Eau Claire and Chippewa Falls, served by Northern States Power Co. . . Southern California Gas Co. (Los Angeles) last month was fighting for permanent increases totaling $16.7 million annually. In February, interim rates bringing an estimated $5.7 million in additional revenues were effected. . . In Jackson, Mich., employees showed their faith in Consumers Power Co. by picking up 21,287 shares of common during a recent issue.

VULCAN DIAPHRAGMS EXCEL IN UNIFORMITY

Maximum uniformity of shape and thickness is one of the many advantages of VULCAN diaphragms. They are extremely flexible, yet they need no oiling—which means a cleaner shop and a saving of time and effort.

VULCAN Diaphragms practically abolish tie leaks, for they are securely fastened to the rings by VULCANIZING plus special wire, and are machine-tested for tightness.

Specify VULCAN Diaphragms, for more accurate metering and a cut in maintenance costs.

VULCAN "THE MARK OF QUALITY" VULCAN PROOFING CO.

Vulcan

PROOFING COMPANY

FIRST AVENUE & 58th STREET • BROOKLYN 20, NEW YORK

EXPANSION

Missouri, Buffalo Lift Lid On Heating Applications

Gas utilities in recent weeks continued to shuck restrictions on space heating installations that have bedeviled them ever since gas became the post-war glamour queen of the fuels world.

While Mountain Fuel Supply Co., Salt Lake City, was happily viewing the record-long queues of gas-heating customers at its doors, two other companies throughout the country were publishing the good news that for them the worm was at long last turning.

Iroquois Gas Co., Buffalo, was authorized by the state commission to open the doors to 4500 more customers. The only sour note was the fact that the company's order backlog is considerably more than 4500.

Restrictions went off last month in Missouri cities supplied by Cities Service Gas Co., Oklahoma City. As of May 1, by state public service commission fiat, commercial space heating of buildings now under construction or proposed was lifted in Kansas City, St. Joseph, Independence, Higginsville, Carrollton, Joplin, Warrensburg, and 18 smaller towns, all served direct by The Gas Service Co., Kansas City, Mo.

Cities Service operates the transmission line which brings gas to the Gas Service system.

An echo of the winter's coal strike came from Minneapolis, where the utility said 2000 applications had flowed in while the strikers were out. While the company has a 13,000 backlog, it hopes to handle 11,000 conversions, 4000 new homes this year.

Queue

No, that wasn't a world series crowd lined up waiting for tickets. It wasn't even a cigarette line left over from the late war.

It was the longest queue ever seen in Salt Lake City, and the folks were waiting for—gas.

When Mountain Fuel Supply Co., in compliance with a state commission order, opened its order books for 5000 house-heating installations *(GAS,* April, p. 54) March 18, 5000 heat-hungry citizens lined up four abreast in a ribbon stretching for three blocks. In Provo and Ogden, Utah, which were to share in the 5000 allocations, another 5000 showed up early—2000 in Ogden, an estimated 3000 in Provo.

The result: in five days, quotas were oversubscribed 150%.

The early birds started lining up at gas company offices at 4 p.m. Friday, the day before applications were to be taken.

Mountain Fuel received tremendous publicity. Recognizing the story as a natural, Utah newspapers unanimously made it "page 1 stuff." Montages and picture spreads were abundant.

Sales Techniques Demonstrated At PCGA Workshops

What are the surest methods for closing a sale?

How can a salesman *tell* a customer about an appliance, rather than merely *talking* about it?

How can questions about price be answered without building up customer resistance?

These and other problems were dealt with in detail when the Pacific Coast Gas Assn. held its Sales Training Council Workshops in Los Angeles March 28 and San Francisco March 29. A dialogue technique, employing top coast gas salesmen in roles of wise old-timers and bewildered neophytes, was used to put across the sales lessons.

W. D. Milton, Southern Counties, and C. C. Martin, Major Appliance Distributing Co., explained closing methods. First, build a solid base for closing by making certain the customer has a complete understanding of the advantages of the product, building the customer's confidence in one's self, and creating a desire to possess. Then three habits, or attitudes, must be built up in the salesman's own mind: make a habit of attempting to close the sale, develop closing confidence, and *want* to close the sale.

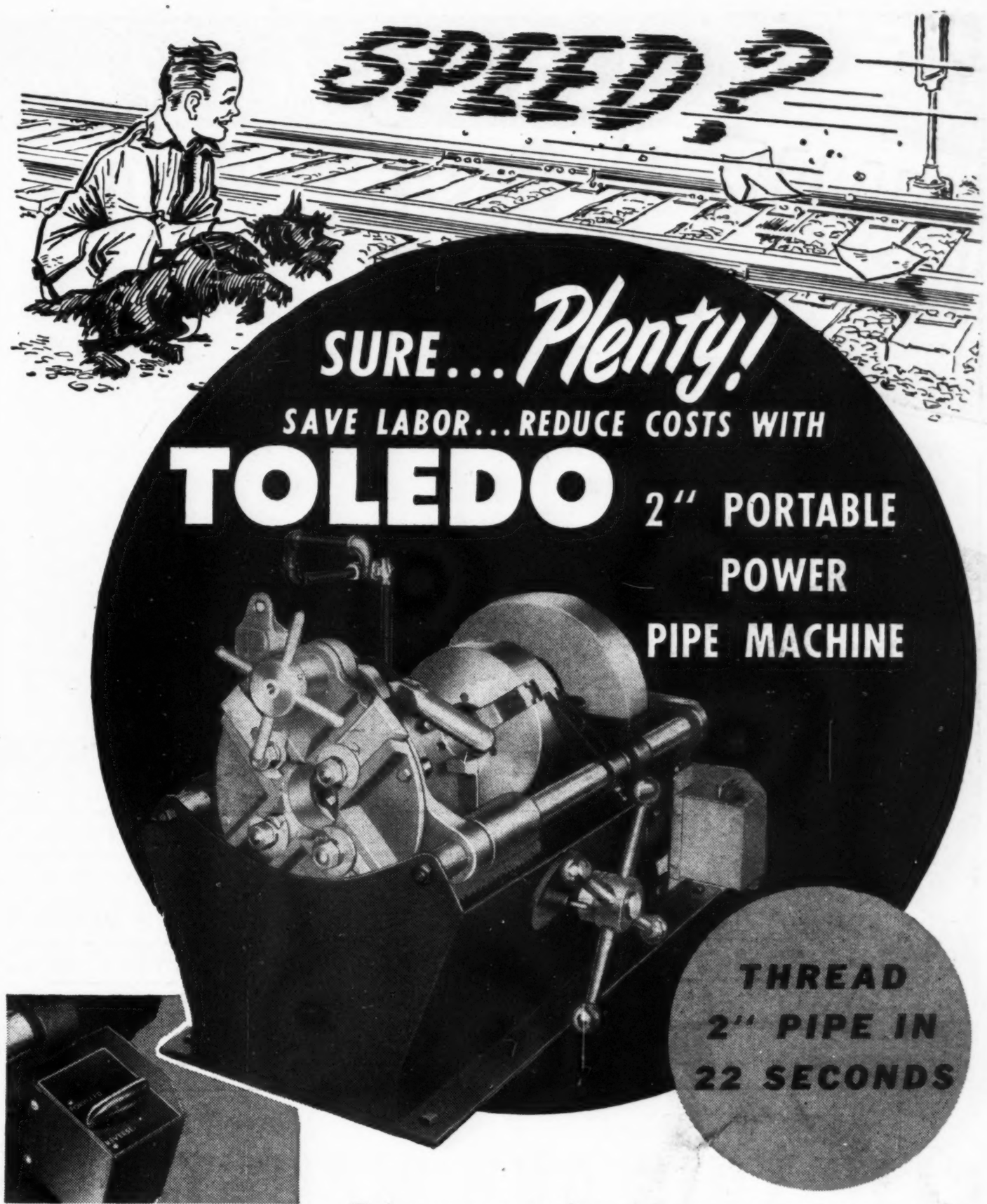
Next, he must recognize certain customer traits—for example, it's easier to say "yes" than to say "no"; yet he will put up defenses in trying to resist the sale; and he is liable to have a "fear" of the order blank, which can be introduced early in the sales presentation in a casual manner.

When should the closing be started? Often the customer will give a sign, through actions or questions. Or the "trial close" may be used to get the customer used to saying "yes" and determining if sales pointers need further elaboration.

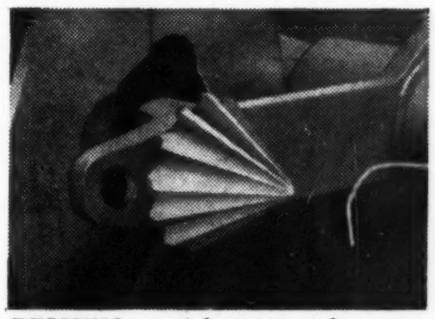
When ready for the close, these methods may be used: the "Expect Them To Buy" technique, assuming that the customer is ready to buy without asking him; the "Closing on a Secondary Feature" type, wherein the salesman might get the customer to state which model is his choice; the "Make Them Stop You" (from starting to fill out a contract, for example); the "Avoid a Loss," in which the salesman brings up a circumstance which requires immediate action; the "Tell Him a Story" method of citing a sale to a similar person in whose place the customer may place himself; the "Incentive" closing, in which a special offer is made; as a last resort, the "Ask Them to Buy" angle.

Another dialogue, "The Middle Road," presented by Jack Brembeck, Western Stove, and H. F. Jacobsmeyer, A. O. Smith Corp., showed how salesmen could ease the blow of telling the customer the price of a product. The secret lies in explaining at the same time the fact that such a product may be had in many price ranges, and what advantages the model being demonstrated has over cheaper lines.

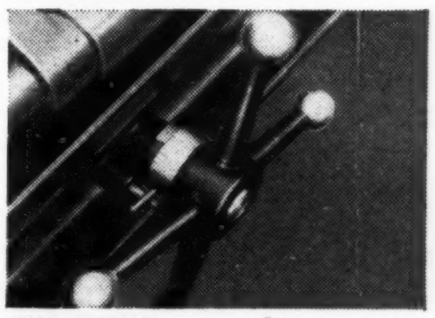
In a third training session, with Fred E. Isslieb, Southern California Gas Co., and W. M. Harrison, Coast Counties Gas, "Prep-



CONTROLS . . . entirely within forward and reversing switch. Speed adjusted automatically.



REAMING...with 12 tooth cone type fluted reamer mounted on arm on cutter head.



THREADING... speedy, accurate. Thread gauge shows length of thread being cut.

CUTTING... especially fast with 4 cutting knives. Perfect square end cuts. No burred edges.

Bring your costs down—save up to 80% on pipe threading time by using a portable TOLEDO No. 999 Power Pipe Machine instead of hand methods!

Gives you high production! The Super Model threads 2″ pipe in 22 seconds . . . or 30 seconds with Standard Model. Cuts off 2″ pipe in 10 seconds. It's versatile—quickly changed for all pipe sizes up to and including 2″. It's rugged, compact, low in cost . . . with proven performance and Toledo dependability! Ask your distributor for complete details and price. Write for new catalog. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

RELY ON THE LEADER

TOLEDO

PIPE TOOLS...POWER PIPE MACHINES...POWER DRIVES

QUIET

Peerless forced air

Gas Circulators

Where QUIET fan circulated heat is paramount this new unit fills the bill . . . solves difficult heating problems. Essentially for those requiring QUIET forced-air heat where other forms of more rapidly moved air is not desirable, or where gravity circulation is inadequate.

A.G.A. APPROVED FOR ALL GASES INCLUDING L.P.

WRITE FOR COMPLETE DETAILS TODAY!

A NEW MODEL — A NEW FINISH
EYE APPEALING — SMART STYLING
TWO SIZES — 45,000 AND 60,000 B.T.U.
AUTOMATIC FAN CONTROL — MANUAL AIR VOLUME
AUTOMATIC TEMPERATURE CONTROLS FOR EVERY NEED
STYLED TO SELL—BUILT TO SATISFY—MADE TO LAST

PEERLESS MANUFACTURING CORP, LOUISVILLE 10, KY.

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IF YOU ARE NOT A REGULAR SUBSCRIBER TO GAS

In GAS each month you will find dozens of ideas that will help you know your business better and do your job better. Just one of these ideas coming to you on our pages can pay you many, many times the small cost of a subscription.

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☐ Check is enclosed ☐ Please bill me

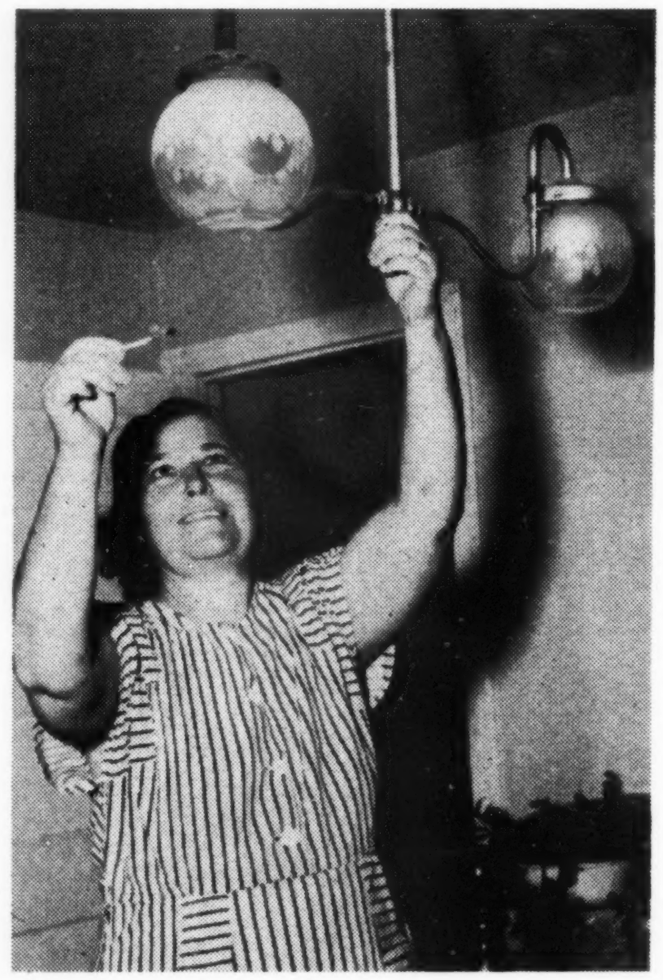
NAME_____ POSITION_____

COMPANY_____

STREET CITY ZONE STATE

aration of a Sales Presentation" was the theme. Instead of talking about an appliance, the salesman should tell the customer about it—what it will do for him, and how. Thus, when making a sale, the salesman should (1) name the feature, (2) tell him how it work without going into technical details; and (3) tell the customer what the feature will accomplish for him. It is the failure to follow through carefully to step 3 that often proves the stumbling block of sales, it was brought out. Such a failure leaves the customer behind the salesman in his talk, and creates confusion.

Other highlights of the program, chairmanned by Dan L. Turner, San Diego Gas & Electric, included talks by Mr. Turner, J. S. C. Ross, Pacific Gas & Electric Co.; S. E. Cowan, Mountain Fuel Supply Co.; C. W. Steele, Portland Gas & Coke; and Seward Abbott of Servel.



Who said gas lights are old fashioned? Not Mr. and Mrs. W. F. Broyles, customers of Lone Star Gas Co. living near Denton, Texas. Located in an area where storms occasionally cut off electric power, they replaced their light fixtures with gas-light equipment purchased from an old house. Lone Star scared up some mantles and they were all set. Surplus fixtures they sold to neighbors during a recent storm.

ONE OF THE LARGEST drug chains in the southwest will display and sell Servel gas refrigerators in most of its Dallas, Texas, stores before the end of the year. Skillern's Drug Stores, with an estimated 80,000 people walking through their Dallas units daily, is establishing new major appliance departments in 10 stores where a complete line of Servels will be displayed. In other stores where space is limited, one or more models will be on display.

In the new departments, six specialty salesmen will be on duty to handle these appliances exclusively, alternately working on store and field contracts. Harry Hall has been named appliance sales supervisor for the drug chain.

Court of Flame "Oscars"

For chalking up the greatest number of Court of Flame water heater sales during the recently completed GAMA campaign, six gas companies have been presented sales trophies—"Oscars" of the gas water heater industry. Awards were made on the basis of sales by dealers and salesmen per thousand residential meters during the 1949 drive.

Winners include The Brooklyn (N.Y.) Union Gas Co., Rochester (N.Y.) Gas & Electric Corp., The Hartford (Conn.) Gas Co., Delaware Power & Light Co., Wilmington; East St. Louis (Ill.) Division, Illinois Power Co.; and the Spring Valley (N.Y.) Division, Rockland Gas Co. Inc.

According to reports concerning the first month's campaign of the 1950 Court of Flame contest, which started March 1, a number of utilities, dealers, and salesmen are already eyeing 1950 awards. Leland M. Feigel, chairman of GAMA's gas water heater division, announced that 13,356 participants registered during the month, and 256,685 tags were sold to manufacturers.

Kitchen Cavalcade Success

"We sold at least 12 complete kitchens as a result of our first quarter's display during the so-called 'quiet' season, and hope for even greater response to our current room setting,"—so says one of the seven enthusiastic cooperating local distributors, who have been participating in the "Gas Kitchen Cavalcade" at the Minneapolis Gas Co. and the other six companies are equally enthusiastic.

This is a story of the happy combination of floor space and advertising promotion assistance donated by the gas company plus equipment and interior decoration donated by seven local firms, which has resulted in the successful year-long promotion of New Freedom Gas Kitchens.

The gas company planned the whole promotion and offered four display windows and three floor displays to a number of local firms. The first display, worked out cooperatively by the company's "kitchen planning center" staff and the distributors themselves, opened to the public in November, and met with instant success. The second was set up early in March. Cooperating companies agreed to change their displays and decor four times during the coming year. In all cases local stores have also been given window credit for their assistance and for accessories they furnish.

The gas company sent invitations in bill inserts inviting customers to see displays from 8 to 5 on week days and Saturdays. Engraved invitations were also sent out to architects, contractors, home economics teachers, presidents of PTA's, and other groups to arouse interest. More than 1000 employees of the company also were invited to attend the displays so they would be acquainted with the promotion. The gas company is currently tying in with the national campaign and spring style show.

According to Sales Manager E. J. Boyer, from 6 to 15 persons from the home service, sales and kitchen planning departments have been on the floor constantly to talk to prospective customers and interested parties to

SHOPPING FOR BLOWERS?

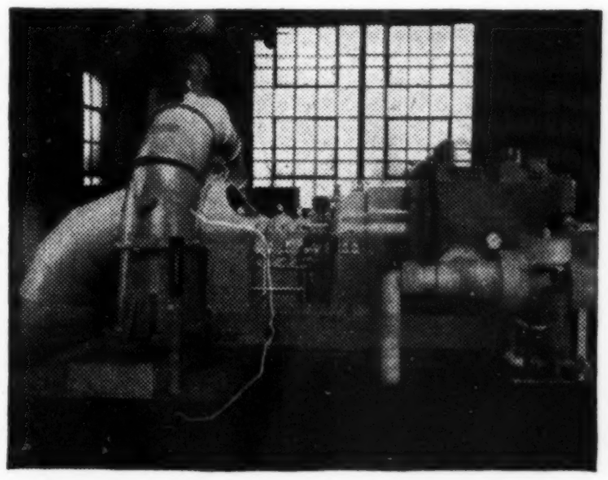
Look at *R-C dual-ability* with its wide selection to suit almost any job

Asking Roots-Connersville about blowers, exhausters and gas pumps has been standard practice among buyers for almost a century. That's because building such equipment is the only job we do. We're outstanding specialists in handling gas and air.

You'll gain from our wide varieties of sizes, types and capacities from 5 cfm to 100,000 cfm. We're the only manufacturers offering you the *dual-choice* between Centrifugal and Rotary Positive designs—and that *dual-ability* is important when it comes to matching the units to the jobs to be done.

So—when shopping, be sure to call on Roots-Connersville, the specialists. When you're interested in vacuum pumps, meters or inert gas generators, we're equally well fitted to fill these needs, too.

ROOTS-CONNERSVILLE BLOWER CORPORATION
505 Oregon Avenue, Connersville, Indiana

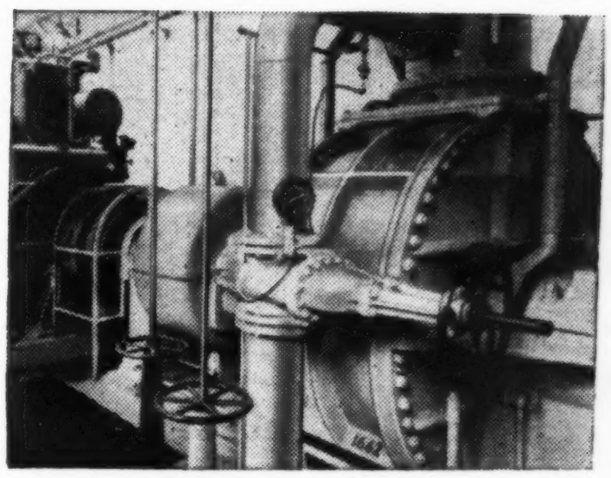


CENTRIFUGAL

Single-stage, Type OIB Gas Exhauster in gas utility plant. Capacity 39,950 cfm.

Rotary Positive Gas Pump driven by Clark Bros. Gas Engine in eastern plant. Capacity 20,833 cfm.

ROTARY



ROOTS-CONNERSVILLE

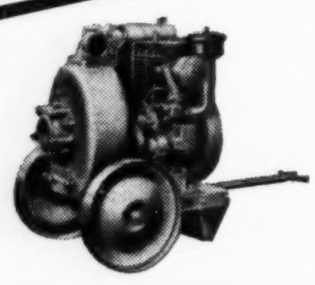
BLOWER BUILDERS R-C SINCE 1854

ONE OF THE DRESSER INDUSTRIES

for **low-cost** pumping

JAEGER invites 5-way comparison with any other pump

1: Priming speed
2: Vacuum, capacity and pressure
3: Gallons water moved per gallon of fuel
4: Self-cleaning ability
5: Hours of service per dollar invested



Latest type 2" and 3": Compact heavy duty units with weather-shielded engines.

4" to 10" Portables: Specially housed for easy access to engines, larger fuel tanks.

Aluminum Pumps: with replaceable liners, stainless steel shell fitting. 1½", 60 lbs., up to 5700 gph.—2", 105 lbs., 9000 gph.

Jetting Pumps: For pressures to 275 lbs. Also 2" to 8" pressure pumps for supply work. Diaphragm pumps for sand and mud.

Ask for Complete Pump Catalog

THE JAEGER MACHINE CO.
Columbus 16, Ohio
Distributors in 130 Cities of U. S., Canada

AIR COMPRESSORS • MIXERS
HOISTS • AGGREGATE SPREADERS
BITUMINOUS PAVERS
CONCRETE SPREADERS • FINISHERS

Typical of the first group of New Freedom Gas Kitchens displayed by Minneapolis Gas Co. is this room designed by Sigwald Engineering Co., one of the cooperating local distributors. Note laundry room at left.

give them lowdown on the displays. Live demonstrations also have been tried.

The company has put out a single-page catalog for each display, listing the distributors of cabinets, as well as local dealers carrying all gas equipment. Not only are retailers of appliances, furnishings, and accessories given name credit, but all color schemes are fully described on the catalog page. There is also a complete floor plan of the series, showing how each display is set up.

Cooperating companies have concentrated on presenting the latest ideas for the kitchen. As one dealer put it, "over the years every room but the kitchen has been remodelled. Now with the help of the gas company we are showing people the wonderful things that can be done with this all-important room."

SOUTHERN METHODIST University in Dallas, Texas, will be the first completely air conditioned large university in the country when installation is completed on a new natural gas-fuel steam turbine system.

A 1250-hp Westinghouse steam turbine unit will operate the 1000-ton centrifugal compressor and is part of the equipment purchased from the former Michaud Industrial Facilities plant in New Orleans. It will be installed this year for 1951 operations. The new equipment will condition all buildings with the exception of dormitories.

TWO TOP BRAND names—Magic Chef ranges and Gold Medal flour—have joined forces in a nationwide store traffic-producing promotion. Local contests are being held, with Magic Chef ranges as prizes. Official entry blanks, to be filled in with 25 words stating "I like to shop in (name of town) because . . ." are picked up at the grocery store and deposited with the appliance dealer. Gold Medal flour salesmen demonstrate on Magic Chef ranges in the grocery stores.

R. Noll **L. Stanier** **A. Clarke** **E. Howe** **R. Havens**

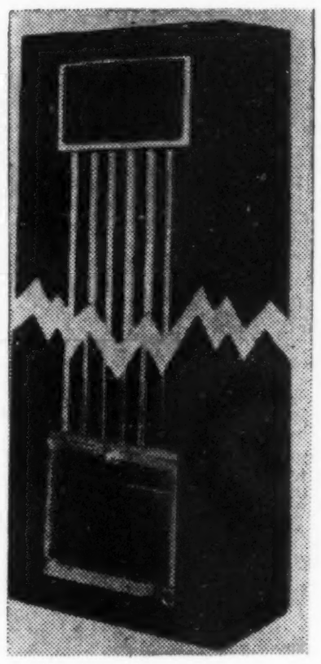
From a group of entrants representing more than 50 companies, Allan G. Clarke, sales promotion manager, Portland (Ore.) Gas & Coke Co., was selected for first prize award of $200 in the gas incineration contest sponsored by the AGA gas incineration committee.

Second and third awards of $100 each went to Mrs. Lillian E. Stanier, Equitable Gas Co., Pittsburgh, and E. Lewis Howe, Southern California Gas Co., Los Angeles. The $50 fourth and fifth prizes were presented to Richard G. Noll, Peoples Natural Gas Co., Pittsburgh, and Robert C. Havens, The Binghamton (N.Y.) Gas Works.

Of the five winners, only Mr. Clarke is actually engaged in promotional or advertising work. His entry consisted of a suggested gas incinerator advertisement with accompanying layouts.

NEW PRODUCTS

Wall Circulator



JOHN ZINK CO., 4401 S. Peoria, Tulsa, Okla.

MODEL: Radiant wall circulator.

DESCRIPTION: This AGA-approved wall heater may be installed by making a small hole for the flue adapter plate and removing about 18 in. of baseboard. Low flue temperature proves the efficiency of this heater, the manufacturer states. Special engineering prevents scorching. The combustion chamber, which runs the full length of the unit, radiates heat into the room from behind the bar grille on the front. The heater also gives convected heat through the slotted grille at the top. Input rating is 25,000 Btu/hr. Width is 17½ in., height 70 in., and depth 8 in. at base.

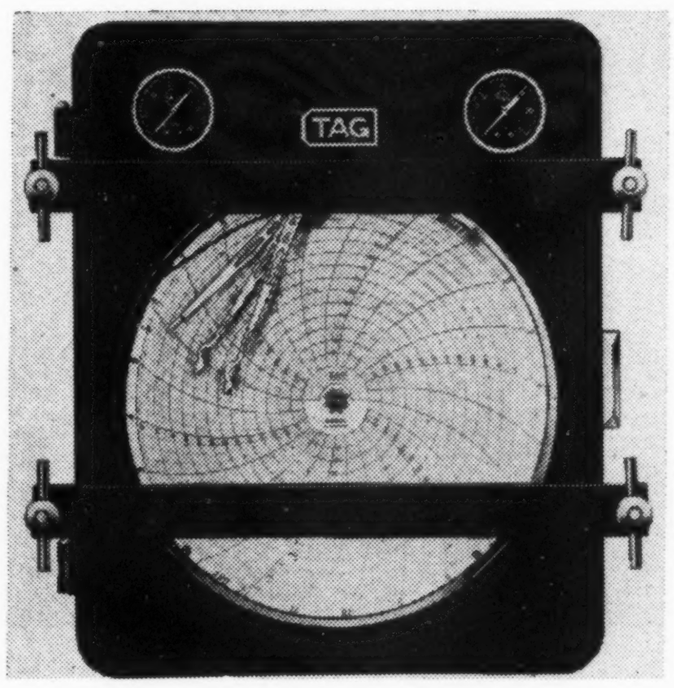
Humidity Controller

WESTON ELECTRICAL INSTRUMENT CORP., 614 Frelinghuysen Ave., Newark 5, N. J.

MODEL: Tagliabue humidity controller.

APPLICATION: For utilities and process industries.

DESCRIPTION: This instrument records and automatically controls humidity utilizing the psychrometric wet and dry bulb principle. It regulates the wet-bulb (relative-humidity)



depression for which it is set, regardless of any fluctuations in the dry-bulb temperature. Two pens operate on a circular 10-in. chart, simultaneously recording dry-bulb temperature and wet-bulb depression. Flow of the humidifying agent, moisture, steam, or oil fog, is regulated by a valve which is operated by the instrument. For applications involving gas, such as the saturation of natural gas in the main, bars can be clamped on the case of the instrument to make it gas-tight.

Catalog No. 1287 describes this instrument.

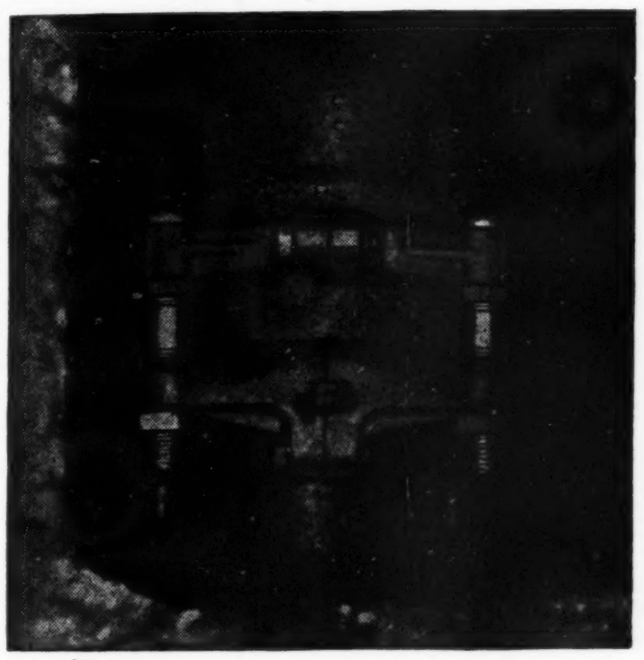
A SIMPLE SOLUTION for one of the GAS INDUSTRY'S *most trying problems*

the NORMAC

BELL JOINT CLAMP

SOLVES YOUR JOINT REPAIR PROBLEMS

6 inch Normac Clamp being lowered into hole for installation



6 inch Normac Clamp in service after installation

QUICK • EASY • PERMANENT

Installed in small pavement openings. Available in all standard sizes from 3" to 12". A simple set of tools cleans the joint, installs the clamp . . . often in only a quarter of an hour. SAVES TIME. SAVES MONEY and the repair is permanent. Designed for all conditions particularly where pavement repair costs are prohibitive. Such small opening repairs are scarcely noticeable when pavement is replaced.

Normac Clamps can be installed in large as well as small openings.

Norton - McMurray hold definite leadership in the development of methods for installation and rehabilitation work through small openings. We welcome the opportunity to help solve a problem you may have—tell us about it.

Write for our catalog describing our complete line of COUPLINGS . . . FITTINGS . . . SERVICE TEES and ELLS . . . SLEEVES . . . COMPRESSION-END COCKS . . . METER BARS and BRASS FITTINGS for copper pipe.

NORTON-McMURRAY MFG. CO.

39 SOUTH LA SALLE ST. • CHICAGO 3, ILL.

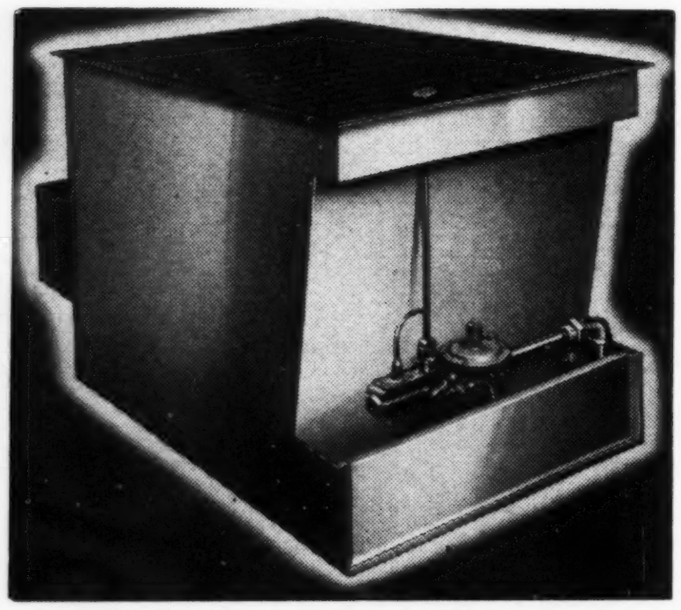
Method and product covered by U. S. Patents, Nos. 2,163,261 and 2,178,286.

Floor Furnace

BRYANT HEATER DIVISION, Affiliated Gas Equipment Inc., 17825 St. Clair Ave., Cleveland, Ohio.

MODEL: No. 365 floor furnace.

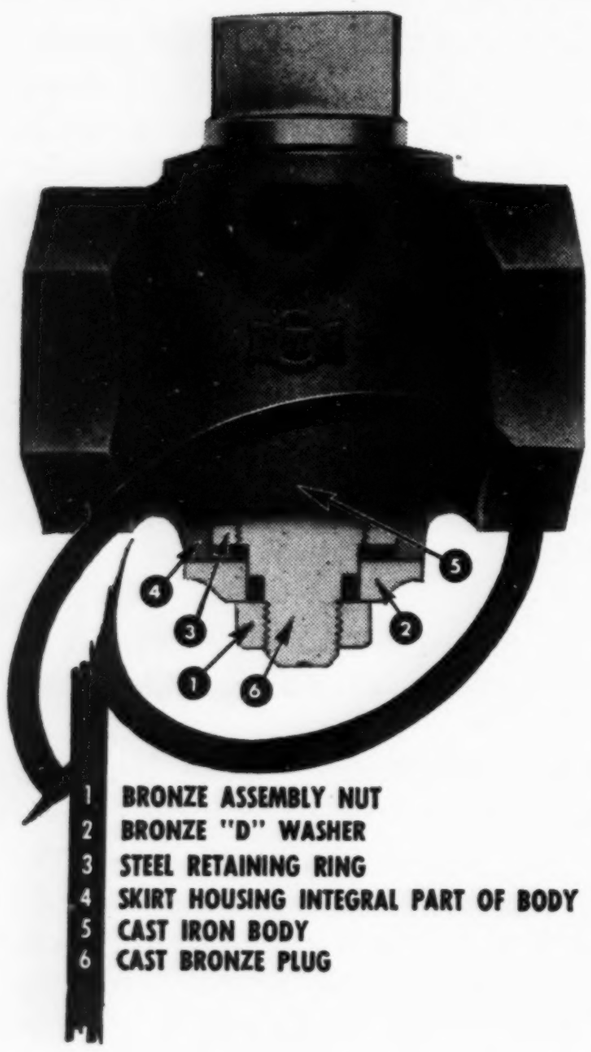
DESCRIPTION: This factory-assembled gas-fired unit is designed for suspension at floor level. Overall depth is 25 in., with the lower 6 in. of casing completely waterproof for protection of controls and burners. Available with hourly Btu input of 35,000 50,000, or 65,000, the furnace has a "complete gas shutoff" feature. Manual or automatic controls are available, and the register may be floor or dual-wall type. Service operations and adjustments are said to be easily accessible from above the floor.



HAYS®

TAMPER-PROOF GAS STOPS

FEATURES


1 BRONZE ASSEMBLY NUT
2 BRONZE "D" WASHER
3 STEEL RETAINING RING
4 SKIRT HOUSING INTEGRAL PART OF BODY
5 CAST IRON BODY
6 CAST BRONZE PLUG

- Tamper-Proof Design with Non-Removable Plug.
- Extra Grade Gray Iron Body, Gas Service Bronze Plug.
- Steel Retaining Ring Prevents Removal of Plug.
- Steel Retaining Ring Assembled to Bottom of Plug—Eliminates Possible Damage to Precision Ground Surface of Plug and Body.
- Steel Retaining Ring Threaded and Staked to the Largest Metal Diameter on Bottom of Tapered Plug—Assures Retention without Distortion.
- Steel Retaining Ring Anchored without Drill Hole or Pin—Eliminates Possible Shearing of Plug.
- Steel Retaining Ring Located below Shoulder of Body—Permits Freedom for Service Adjustment of Plug.
- Steel Retaining Ring Recessed and Inaccessible within Iron Body—Gripless and Shearless.
- Plug and Body Precision Ground and Matched for Perfect Seating.
- Individually Tested Under Rigidly Controlled Inspection.
- Lubricated with a Compound of Greases Suitable for Use with Manufactured, Natural or Liquid Petroleum Gases.
- Obtainable in a Variety of Patterns.

Write for Folder 120–C

AVAILABLE IN

Black or Galvanized

Flat Head Less Check
Flat Head With Check
Flat Head With Lock-Wing

Sizes; ¾"—1"—1¼"—1½"—2"

Also HAYS STANDARD
HEAVY PATTERN IRON BODY GAS STOP

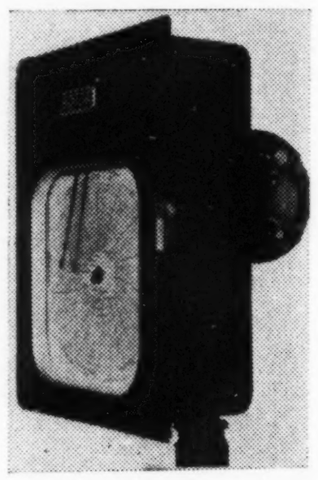
For 75 Years the Gas Industry has relied on HAYS Iron Body Gas Stops

Flow Meter

BARTON INSTRUMENT CORP., 1429 S. Eastern Ave., Los Angeles, Calif.

MODEL: 202 Recorder.

DESCRIPTION: This rupture-proof, bellows-type flow meter is equipped with an internal, adjustable pulsation dampener. The meter is completely self-draining. When gas is being measured, any slugs of liquid entering the meter housing will drain out automatically. The meters are fitted with a torque tube instead of a pressure-tight bearing to insure permanently high accuracy and freedom from lubricant and leakage problems.



The dampener controls the rate of flow of the hydraulic fluid within the bellows mechanism from one bellows chamber to the other. The adjustment may be made while the meter is in service. Because the hydraulic fluid is permanently sealed within the bellows mechanism, the pulsation dampener assembly can never plug or lose its effectiveness.

Range

CALORIC STOVE CORP., 1242 Widener Bldg., Philadelphia 7, Pa.

MODEL: No. 7628-UX 36-in. four-burner divided top Streamliner.

DESCRIPTION: Several variations of back-guard accessories are available. The illustration shows clock and timer, electric outlet, and enclosed fluorescent top light. The storage compartment is all porcelain and has a shelf. Oven window and interior light are optional. The range is available built to CP standards and with automatic oven time control.

Order Case

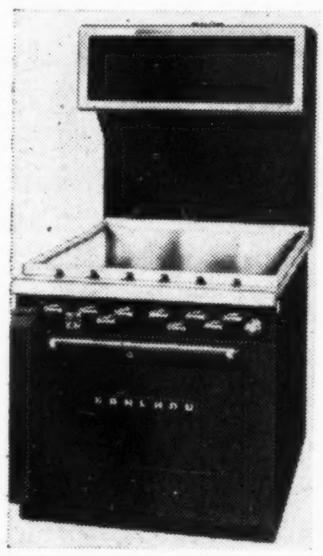
REMINGTON RAND INC., 315 Fourth Ave., New York 10, N. Y.

DESCRIPTION: This meter or service order

card carrying case for servicemen is a wallet-type kit of sturdy leather which holds 6 x 4-in. order cards securely against a firm surface for easy posting and provides a pocket in which to place the completed orders.

Small enough to fit into an overcoat pocket, yet substantial enough to permit comfortable posting without the aid of a desk or table, the kit serves as a traveling "office" for servicemen.

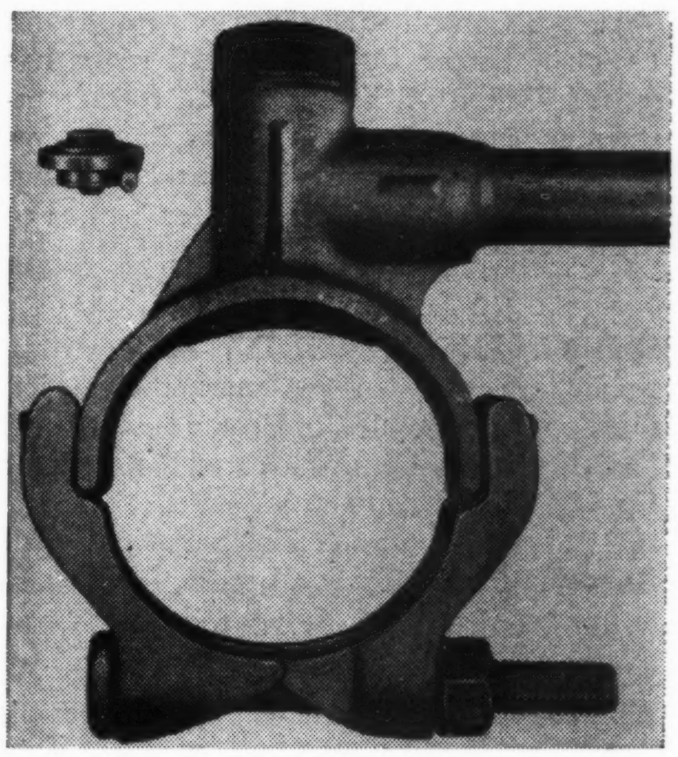
Fry-Top Range



DETROIT-MICHIGAN STOVE CO., Detroit, Mich.

MODEL: Garland commercial fry-top range.

DESCRIPTION: This new model has an increased frying area. The frying surface itself slopes slightly toward a new drain channel which extends across the front for easier drainage. There is also a large-capacity grease container which attaches to the front of the range and lifts off easily for quick emptying. In addition, the frying surface has new higher edges to help reduce spillovers.



Coupling Saddle

M. B. SKINNER CO., South Bend, Ind.

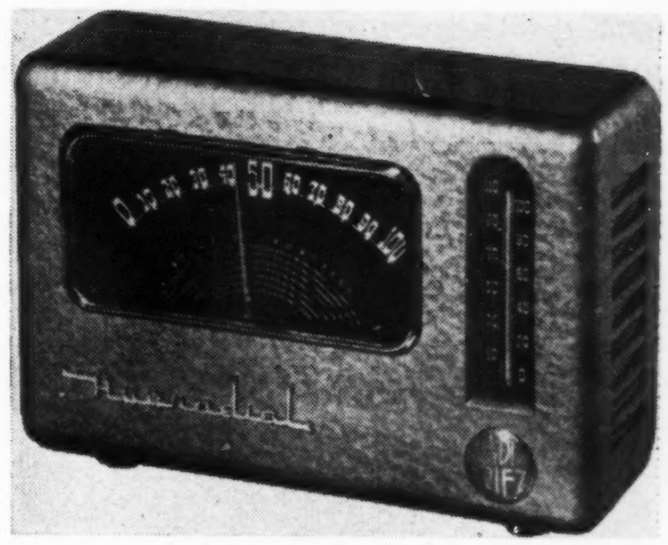
MODEL: Skinner-Seal Coupling Saddle.

DESCRIPTION: This fitting combines service saddle and street tee in one unit, eliminating threads. Installation time is reduced, and by making a single unit of these two fittings, stock-binning should be reduced. The fitting is made of malleable iron and fitted with a single massive bolt. It is machined to receive check valve; outlet has plain end for compression coupling. It is made in three pipe sizes—2, 3, and 4-in. by ¾, 1, or 1¼-in.

Indicator

ABBEON SUPPLY CO., 58-10 41st Drive, Woodside, New York City.

MODEL: Hygrodial relative humidity and temperature indicator.

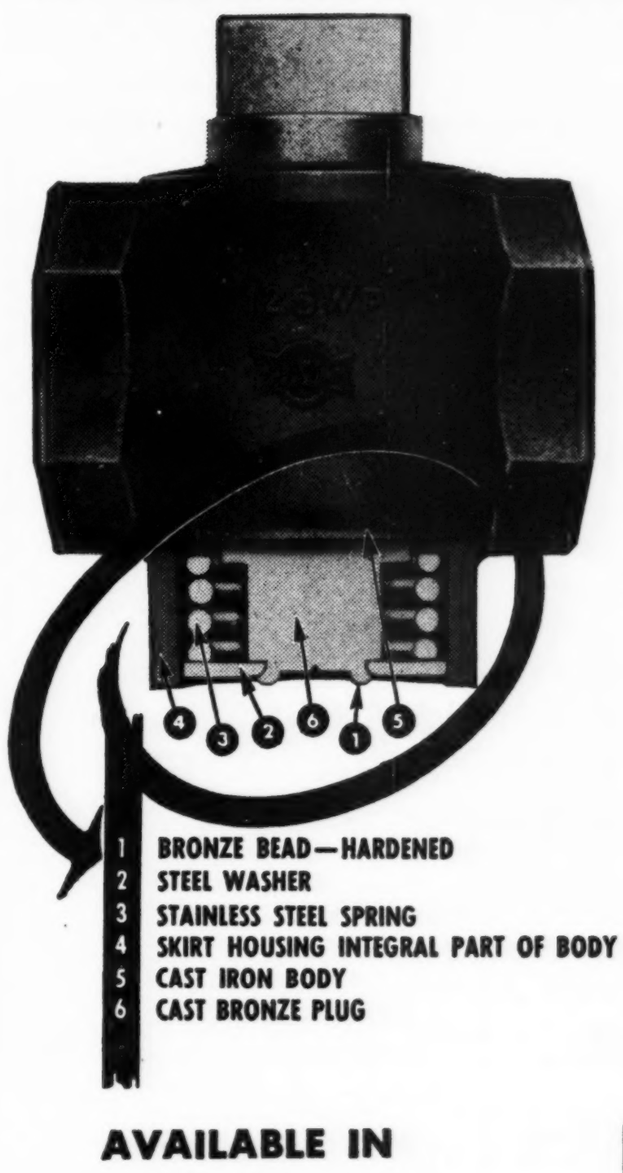


DESCRIPTION: The humidity scale is graduated into 10 equal divisions from 0 to 100% over an area of 2½ in. The ther-

HAYS®

TAMPER-PROOF GAS STOPS

FEATURES



1 BRONZE BEAD—HARDENED
2 STEEL WASHER
3 STAINLESS STEEL SPRING
4 SKIRT HOUSING INTEGRAL PART OF BODY
5 CAST IRON BODY
6 CAST BRONZE PLUG

- Positive Tamper-Proof and Vandal-Proof Design.
- Non-Removable Plug—with Constant Spring Tension for 125# Working Pressure.
- Extra Grade Gray Iron Body, Gas Service Bronze Plug.
- Tough Stainless Steel Spring—Strong Steel Washer, Retains Plug in Body.
- Heavy Bronze Bead, Hardened—Holds Steel Washer to Bottom of Plug.
- All Assembly Parts Recessed and Inaccessible within Iron Body—Gripless and Shearless.
- Precision Ground Plug and Body—Matched for Perfect Seating.
- Lubricated with a Compound of Greases—Suitable for Use with Manufactured, Natural or Liquid Petroleum Gases.
- Spring Tension Allows Free Turning and Reseating of Plug in Body.
- Individually Tested Under Rigidly Controlled Inspection.
- Flow Way Equal to Rated Capacity of Domestic Consumer Meters.
- Obtainable in a Variety of Patterns.

Write for Folder 120-C

AVAILABLE IN

Black or Galvanized

Flat Head Less Check
Flat Head With Check
Flat Head With Lock-Wing

Sizes; ¾"—1"—1¼"—1½"—2"

Also HAYS STANDARD
HEAVY PATTERN IRON BODY GAS STOP

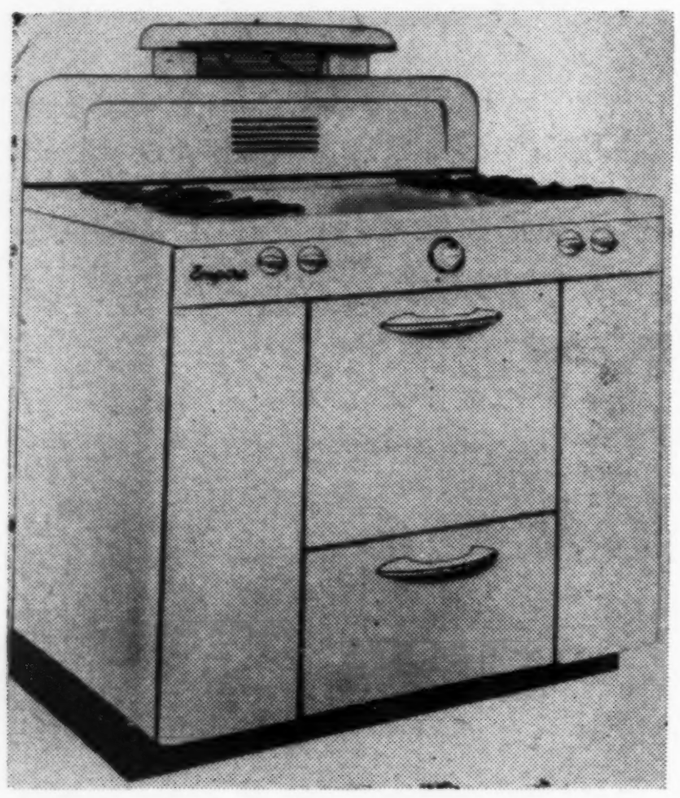
For 75 Years the Gas Industry has relied on HAYS Iron Body Gas Stops

mometer is a lens-front type and is accurate to within 1° at 70°F. Both sets of numerals are satin-finished aluminum on an etched black background.

Range

EMPIRE STOVE CO., Belleville, Ill.

DESCRIPTION: Empire's 1950 line of gas ranges includes the 38-in. divided top model



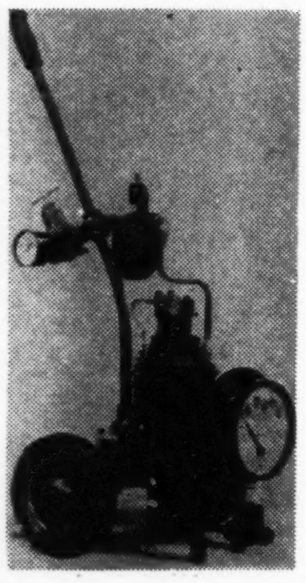
pictured here. Featured are an extra-capacity oven, "glide-out" broiler, and "Touch-latch" storage compartment which has no knobs or handles but opens by a touch of the finger. Other models in the line are 42-in. six-burner or four-burner divided top ranges. They have single or double ovens with high or low broilers, regulator, timer, oven light, and 2½-in. insulation. All models operate on natural, manufactured, or LP-Gas.

Pressure Generator

THE COOPER-BESSEMER CORP., Mount Vernon, Ohio.

MODEL: Intensifier.

APPLICATION: For static pressure testing of boilers, piping systems, compressor cylinders, and similar pressure vessels. Also suitable for many types of laboratory destruction tests where extremely high pressures are involved.



DESCRIPTION: This air-operated hydraulic pressure generating device develops up to 23,000 psi, using air line pressures up to 90 psi. It weighs 80 lb and is mounted on a two-wheel rubber-tired under-carriage for easy portability. To operate, the unit is connected to any compressed air line. The Intensifier draws oil from its built-in supply reservoir. Variable static hydraulic pressures are preset by turning the regulator valve, which is equipped with a dial-type air pressure gauge. Discharge pressures are indicated on a large direct-reading dial gauge.

PLASTIC BASE { FINDS ALL LEAKS QUICKLY

No Guessing -- It's Sure -- Checks All Leaks The Easy Way

Plastic Base—New sensational material especially designed for finding all gas leaks.

- NATURAL
- MANUFACTURED GAS
- FREON
- PROPANE
- NEON
- REFRIGERATION
- ACETYLENE-OXYGEN
- BOTTLE GAS

Just squirt or apply with brush for testing. Plastic Base creates an immediate signal wherever a leak appears.

STOP!
Expensive Return Service Calls

NON-TOXIC
NON-INFLAMMABLE

- NO More Torches
- NO More Smelling
- NO More Guessing
- NO Match Hazard

Send for Trial Quart 50c
Gallon $2.00
50 Gal. Drum $1.10 gal.
5 Barrel Lots $1.00 gal.

Terms 1% 10 Days
F.O.B. Detroit

DETROIT CHEMICAL SUPPLY CO.

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PEOPLE

WARREN L. SMITH, former senior vice president, has been elected president of The M. W. Kellogg Co., New York, succeeding HAROLD R. AUSTIN, who is retiring after 47 years with the company. Concurrently, the executive staff was enlarged with BENNETT ARCHAMBAULT, former treasurer, being elected vice president and general manager, a new post. The board also named G. FRANK BAYES, RONALD B. SMITH and ZARY A. TOULA to be vice presidents. DANIEL J. OLSEN was elected treasurer and comptroller, and EDWIN L. GIDLEY is the new secretary.

FRANK M. PORTER, president of Fain-Porter Drilling Co., Oklahoma City, and of the Mid-Continent Oil & Gas Assn., Tulsa, recently was elected president of the American Petroleum Institute by the board of directors. Mr. Porter succeeds WILLIAM R. BOYD JR., who retired last November. During the interim BAIRD H. MARKHAM, director of the American Petroleum Industries Committee, has served as acting president. Mr. Markham was elected to the institute's board of directors.

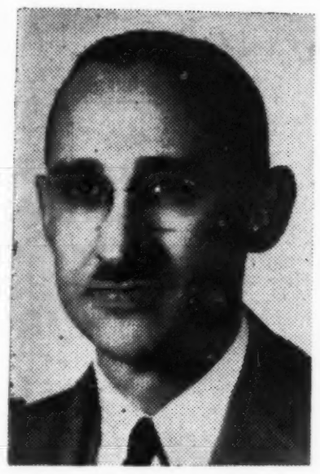
T. G. Hughes

T. G. HUGHES has succeeded GEORGE L. PARKHURST as president of Oronite Chemical Co., San Francisco. Mr. Parkhurst was elected chairman of the board of directors. Mr. Hughes, who joined Oronite's parent company, Standard Oil of California, in 1926, has been with Oronite since its formation in 1943. He has been executive vice president for the last year. Mr. Parkhurst replaced R. G. FOLLIS, who remains as a director.

DEAN W. FLOWERS, general manager of Michigan Consolidated Gas Co.'s Muskegon (Mich.) district for the past 16 years, has retired. GEORGE E. LUDWIG, former superintendent of service in Grand Rapids, has succeeded Mr. Flowers at Muskegon, and CHARLES E. WILCOX has been named to the Grand Rapids post.

DOUGLAS M. CONSIDINE has been appointed manager of the market extension division, general sales, of Brown Instruments Division, Minneapolis-Honeywell Regulator Co. Mr. Considine, who joined the company in 1941, will continue as technical editor of Brown's house-trade publication, *Instrumentation.*

ABNER BAKER has been appointed Detroit district manager of the Janitrol division of Surface Combustion Corp., Toledo. Mr. Baker has been associated with Surface Combustion since 1936. This new arrangement replaces the former Weaver-Janitrol distributorship for the territory.



H. D. Gibson
. . . Crane

H. R. Cook Jr.
. . . Baltimore Con.

H. D. GIBSON, branch manager at Norfolk, Va., for the Crane Co., Chicago, has been promoted to manager of the Richmond, Va., branch. He succeeds W. O. BROWN, who is now manager of the plumbing department at the Chicago general office. Other promotions include those of G. B. BATCHELOR from manager at Roanoke, Va., to manager at Norfolk, and P. J. SINEATH JR. from Greensboro, N. C., salesman, to manager at Roanoke.

HENRY R. COOK JR., vice president of Consolidated Gas Electric Light & Power Co. of Baltimore, and since 1947 a director and member of the executive board of AGA, has retired. Mr. Cook has also been a director of Consolidated since 1947, and he will remain in this capacity as well as continuing to serve as a consultant in connection with the changeover to natural gas. Since joining the company in 1918, Mr. Cook handled the transition from anthracite coal to coke fuel; introduced the use of exhaust steam in the manufacturing process, the application of waste heat boilers at Spring Gardens, and the utilization of oil refinery gas; and for the past few years prepared for the coming of natural gas to Baltimore.

DONALD C. LUCE has been elected vice president in charge of combined operations and a director of the Public Service Electric & Gas Co., Newark, N. J., succeeding the late Jacob T. Barron. The board of directors also elected WATSON F. TAIT JR. as vice president in charge of electric operation, succeeding Mr. Luce, and the appointment of EDWIN H. SNYDER as general manager of the electric department, the post formerly held by Mr. Tait.

The Newark utility has also announced the presentation of the Thomas N. McCarter Electric Award to CLAYTON S. CRONKRIGHT, industrial representative, sales department, in recognition of outstanding work in industrial development of Public Service territory and the state of New Jersey as a whole. The award is given annually to the electric department employee who has contributed the most during the year to the efficiency and progress of the department. Mr. Cronkright has been associated with the company since 1926.

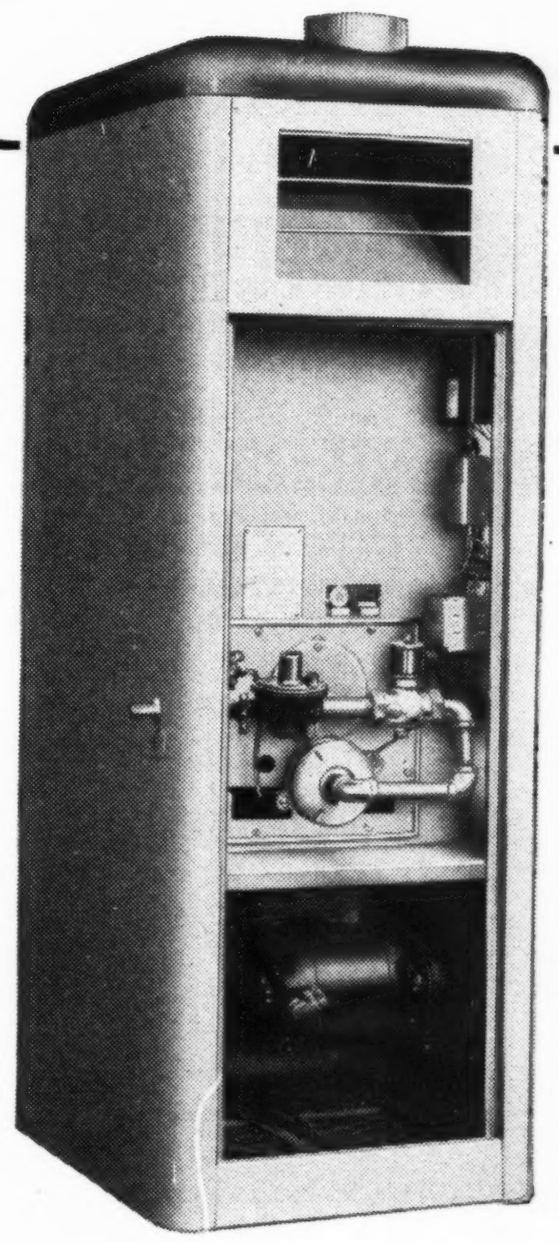
CECIL M. DUNN has been elected a director of Noma Electric Corp. Mr. Dunn is vice president and general manager of the Estate Heatrola Division (Hamilton, Ohio) of the corporation. He has been associated with Estate for 20 years.

ARTHUR J. BRENNAN, works manager for Perfex Corp., Milwaukee, has been elected to the position of vice president. Before joining Perfex in 1947, Mr. Brennan was manager of purchasing and production of General Motors' Rochester products division.

ORVILLE W. BARNETT has been appointed gas products sales supervisor in the Tulsa district for Rockwell Manufacturing Co., Pittsburgh. Mr. Barnett has worked for Rockwell since 1934, recently headquartering in Dallas, where he will remain in his new capacity. JOHN L. LEISENRING has been named sales engineer for the company's territory including southern Indiana and part of southern Illinois. In 1945 Mr. Leisenring became a service engineer in Rockwell's Chicago district, and for the past year and a half he has been assigned to industrial accounts in the Chicago area.

J. L. Leisenring **O. W. Barnett**
. . . Rockwell

LOW or HI-BOY...



This remarkable new

SECURITY

MODEL SFA FURNACE

handles any forced air problem!

Security leads the trend to compact efficiency with the new SFA Series. Adaptable to every domestic winter air conditioner situation. Versatile enough for conventional, basementless or utility room installations. Completely engineered for effortless, automatic heating. Yes, sir . . . the SFA brings greater economy and longer life to home heating!

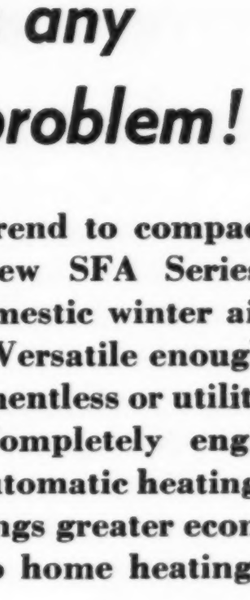
Only Two Connections Necessary

AMERICAN GAS ASSOCIATION · APPROVED · COMPLIES WITH NATIONAL SAFETY REQUIREMENTS

Completely assembled at factory. Hook up just one gas and one power line! Filter racks optional at bottom, right or left. Each control can be removed without disturbing other wiring. You'll be amazed at its versatility. Available for all gases. Write or wire now for complete information, prices.

SECURITY S6P

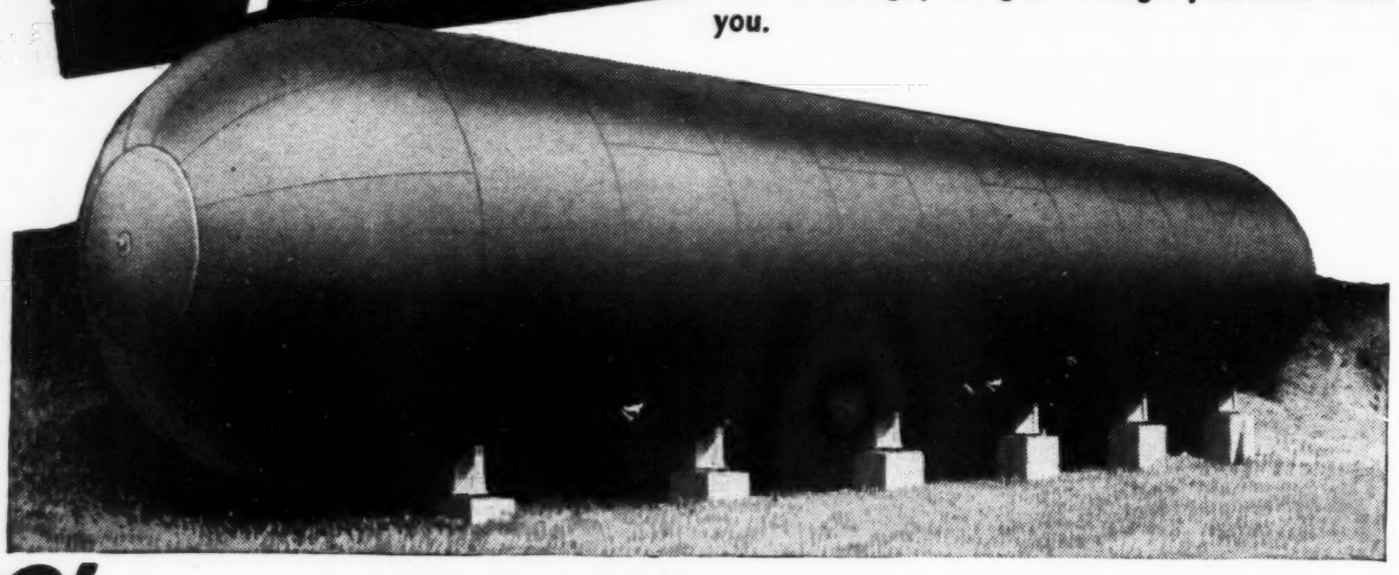
SECURITY MANUFACTURING CO.
1630 Oakland St. • Kansas City 3, Mo.



Also manufacture the famous Security Heavy Duty Water Heater and full Line of Gravity, All-Purpose, and In A Wall Furnaces and Conversion Burners.

STAMANCO
HI-PRESSURE TANKS

Made in both horizontal and vertical types for storing all types of gases under pressure, STAMANCO Hi-Pressure Tanks are soundly engineered and ruggedly built to give long dependable service. All-welded or riveted construction. We would appreciate the opportunity of discussing your gas storage problems with you.



The STACEY MANUFACTURING Co.
SINCE 1851
CINCINNATI 16, OHIO
GAS HOLDERS • HI-PRESSURE TANKS • PURIFIER BOXES
ENGINEERS • FABRICATORS • CONSTRUCTORS
An Independent Organization Not Affiliated With Any Other Builders of Gas Holders

AMONG MEN WHO KNOW

THE ELLIS PIPE CUTTER is BEST FOR CUTTING LARGE SIZES OF PIPE

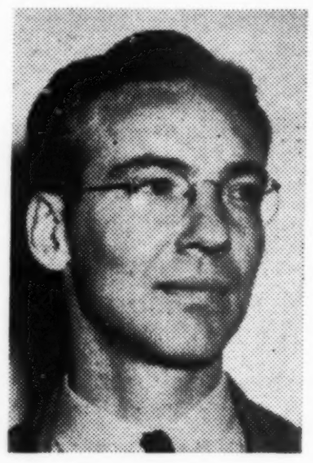
No. 01 Cuts Pipe 4" to 8" | No. 1 Cuts Pipe 4" to 12"

WRITE FOR CIRCULAR AND PRICE LIST "NO. 33 G" ON OUR COMPLETE LINE OF PIPE CUTTING TOOLS.

ELLIS & FORD MFG. CO.
FERNDALE 20, MICH.

HEATH
LEAK LOCATION SERVICE
Invites You to be
THRIFTY IN FIFTY
STOP those gas leaks NOW
WRITE . . . WIRE . . . CALL
HEATH
TREE SERVICE INC.
WELLESLEY, MASS.
CHICAGO SAN DIEGO
RICHMOND, MICH.

MONTE M. TEMPLE has taken over as division manager at Ventura, Calif., for Southern Counties Gas Co., Los Angeles. He succeeds Frank B. Wright, recently elected vice president (April *GAS*, p. 61). Mr. Temple has been superintendent of the company's eastern division since 1947. GEORGE S. COATES, division supervisor of the customers department in the Santa Monica Bay area, on May 15 will become manager of the customers



M. M. Temple

G. S. Coates

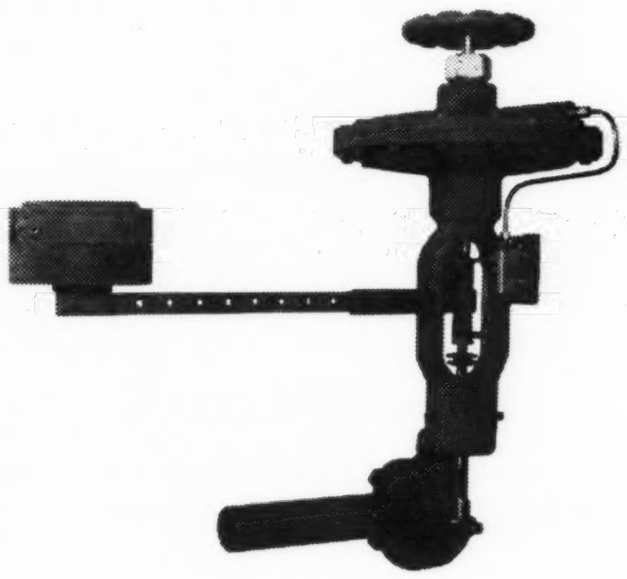
department with headquarters in Los Angeles. THOMAS N. BANKS, special representative, has been named to fill Mr. Temple's position, and RAY W. ANDERSON succeeds Mr. Coates in Santa Monica. WILLIAM C. BULLOCK, Covina office manager, moves to supervisor of the customers department in Ventura, and GARELD K. SHICK, operating department staff assistant in Orange county, takes over as chief clerk of the Texas pipeline division.

GEN. BREHON SOMERVELL, president of Koppers Co. Inc., Pittsburgh, recently also was named chairman of the board of directors. J. P. WILLIAMS JR. retired from that post. W. F. MUNNIKHUYSEN, vice president and general manager of the company's wood preserving division, was named executive vice president. At the same time Mr. Munnikhuysen and JOSEPH BECKER, vice president and general manager of the engineering and construction division, were added to the board of directors. H. R. CONDON, a vice president in the wood preserving division since 1929, now heads that division. R. R. HOLMES, assistant general manager of the tar products division, is now a vice president in that division.

J. W. HUDSON, district superintendent at Pauls Valley, Okla., for Republic Natural Gas Co., has been transferred to the firm's headquarters at Dallas as general superintendent of oil and gas production. He is succeeded by C. C. BOOK, who has been assistant district superintendent.

MARION A. MILLER has replaced C. C. WEST (retired) as manager of Perfection Stove Co.'s Atlanta sales district. From 1936 to 1942 Mr. Miller was a salesman in the Atlanta district. He returned to the company in 1947, and in 1949 he was appointed assistant manager of the district.

JAMES F. WHISLER has been appointed district manager for Detroit-Michigan Stove Co. in the Indiana-Kentucky area. Mr. Whisler will work under the direction of Ward Jacobson, central division manager for the firm.



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GAS COMBUSTION CONTROL

- Operates the BOILER UPTAKE DAMPER
- Uses only 10 CFH of air
- PRECISOR equipped
- Uses butterfly bodies with LOW PRESSURE DROP
- FLOW CHARACTERISTICS match the damper
- Can be furnished with INTEGRALLY MOUNTED MASTER PILOT
- Installed in the gas line as ONE COMPLETE UNIT
- NEW LOW PRICES — PROMPT DELIVERIES

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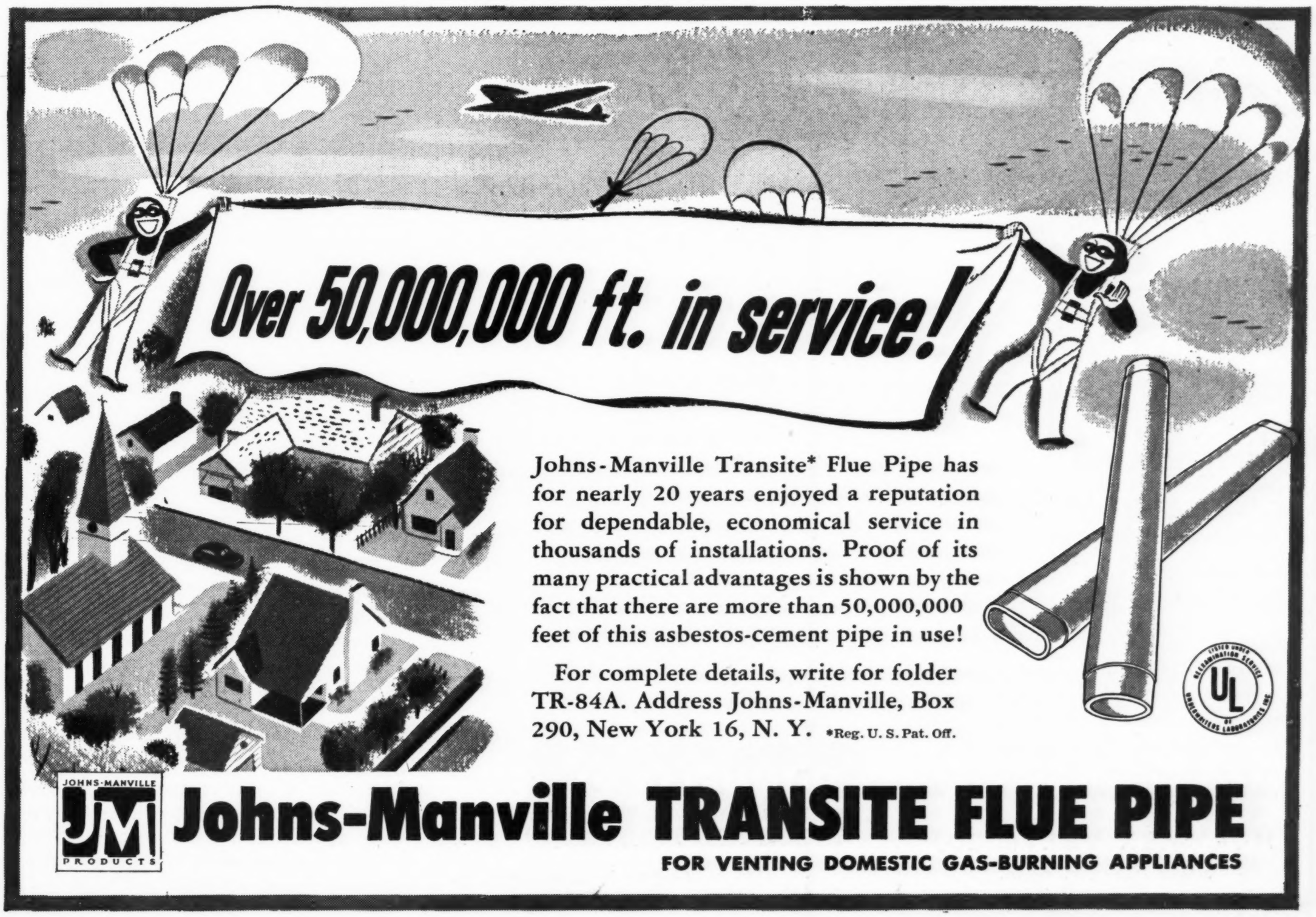
THE WEBSTER ENGINEERING CO.

P. O. Box 2168 • Tulsa, Oklahoma



Johns-Manville Transite* Flue Pipe has for nearly 20 years enjoyed a reputation for dependable, economical service in thousands of installations. Proof of its many practical advantages is shown by the fact that there are more than 50,000,000 feet of this asbestos-cement pipe in use!

For complete details, write for folder TR-84A. Address Johns-Manville, Box 290, New York 16, N. Y. *Reg. U. S. Pat. Off.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE FLUE PIPE

FOR VENTING DOMESTIC GAS-BURNING APPLIANCES

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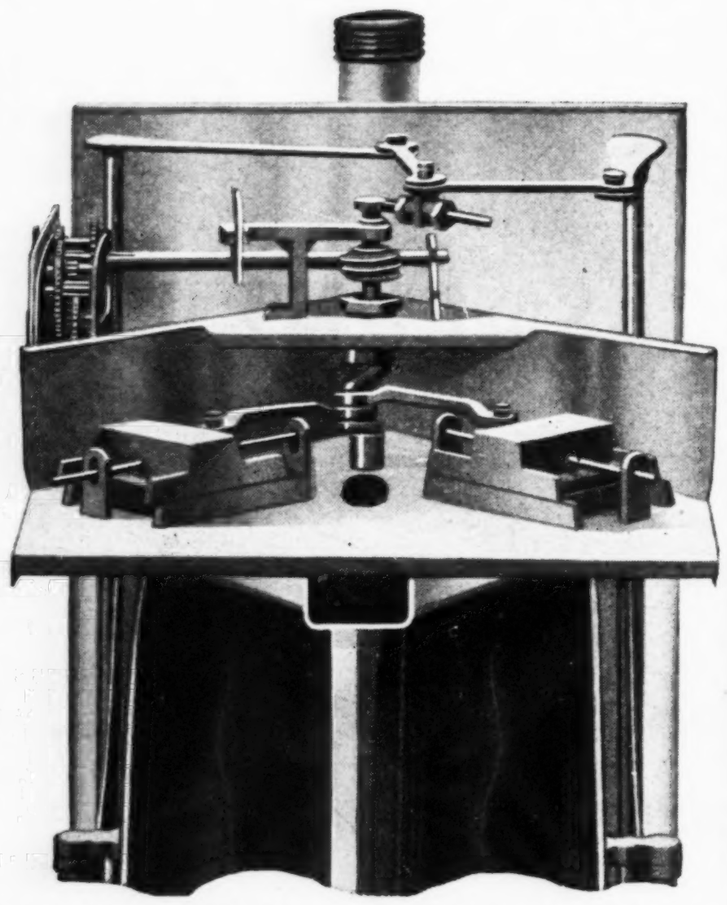

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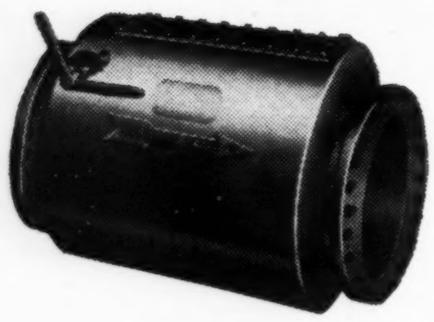

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HAROLD E. JALASS, vice president and general manager of Cribben & Sexton Co., Chicago, has announced the recent expansion of the Universal gas range sales force. Four new men, under the supervision of FRED F. LAUER, eastern sales manager, have joined the company in that area. They are ROBERT BLACKWELL in New England, JOHN PIERCE in New Jersey, and M. E. BRAY and JOHN PHELAN in Maryland, Virginia, and Washington, D.C. D. H. JACKSON, who has been in the company's apartment house sales division, has joined the dealer sales force in the Green Bay, Wis., district and THOMAS L. HANSON was transferred from Green Bay to St. Louis. GEORGE E. PITTS has joined the firm to serve in the Chicago sales division. In addition, an office has been opened in Park Square, Boston, to provide better service to New England customers.

Lucy Eklund

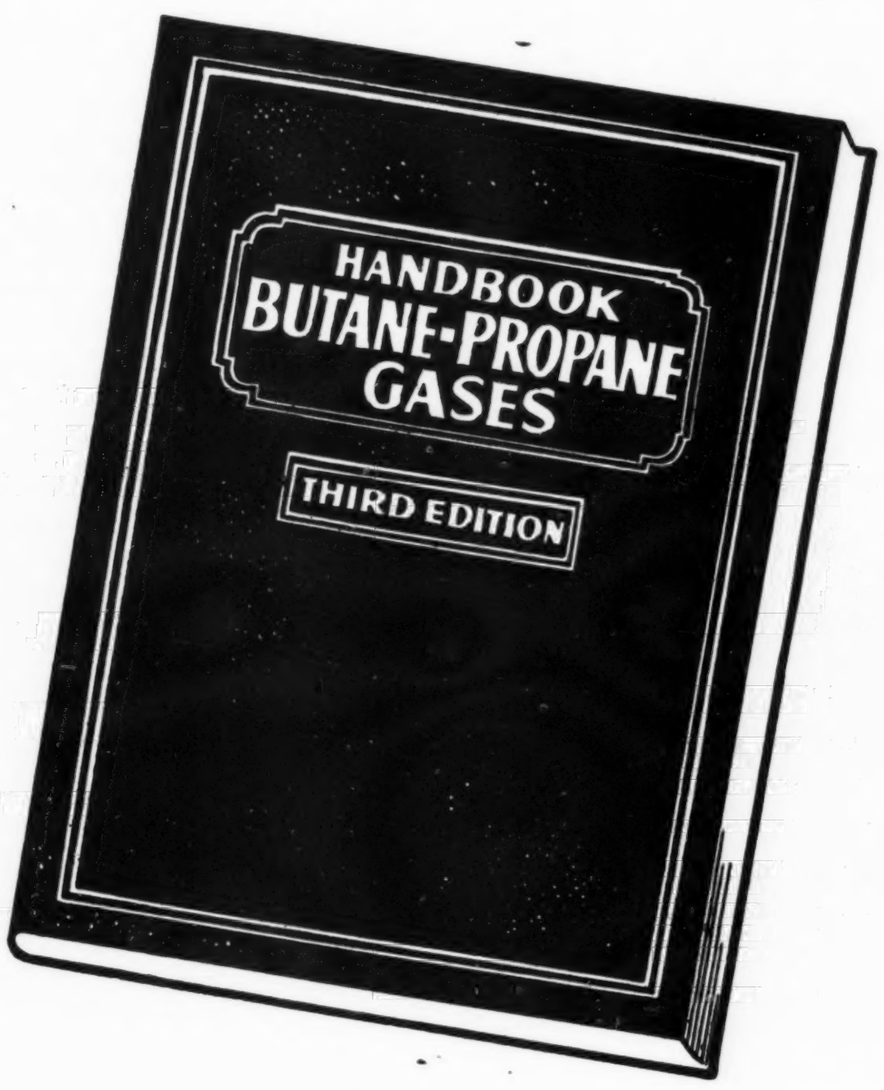
MRS. LUCY EKLUND recently was appointed home economist for the Geo. D. Roper Corp., Rockford, Ill. She will work with the company's sales and research departments in food and product testing. Mrs. Eklund, who has had extensive experience in food photography, demonstration, and recipe testing, has been economist for Swift & Co., Chicago, since her graduation from Purdue university in 1917. At the conclusion of her college work, Mrs. Eklund was honored by the magazine *What's New in Home Economics* for outstanding campus achievement.

ANTHONY J. POTTS has been appointed Chicago district manager of Selas Corp. of America. He was formerly located at the company's main office in Philadelphia. Before his association with Selas, Mr. Potts represented George J. Meyer Manufacturing Co. and was with Brown Instrument Division, Minneapolis-Honeywell Regulator Co.

LARRY L. LADEWIG heads the new firm of Payne-Ladewig Inc., recently appointed wholesale distributor of Payne furnaces in the Dallas region. Mr. Ladewig has been connected with Houston Natural Gas Corp. for a number of years, rising from cadet engineer to director of gas utilization. He has been prominent in AGA and SGA activities.

DAVID J. TIMMONS and WALTER J. COLLINS have been added to the selling organization of the Glenwood Range Co., Taunton, Mass. Mr. Timmons' territory is upper New York state, and Mr. Collins will serve as regional representative for eastern Pennsylvania and southern New Jersey.

RUSSELL W. McINTOSH recently was named west coast representative for Pittsburgh protective coatings, according to Russell H. Coe, manager, Protective Coatings Division, Pittsburgh Coke & Chemical Co. Mr. McIntosh spent six years with North



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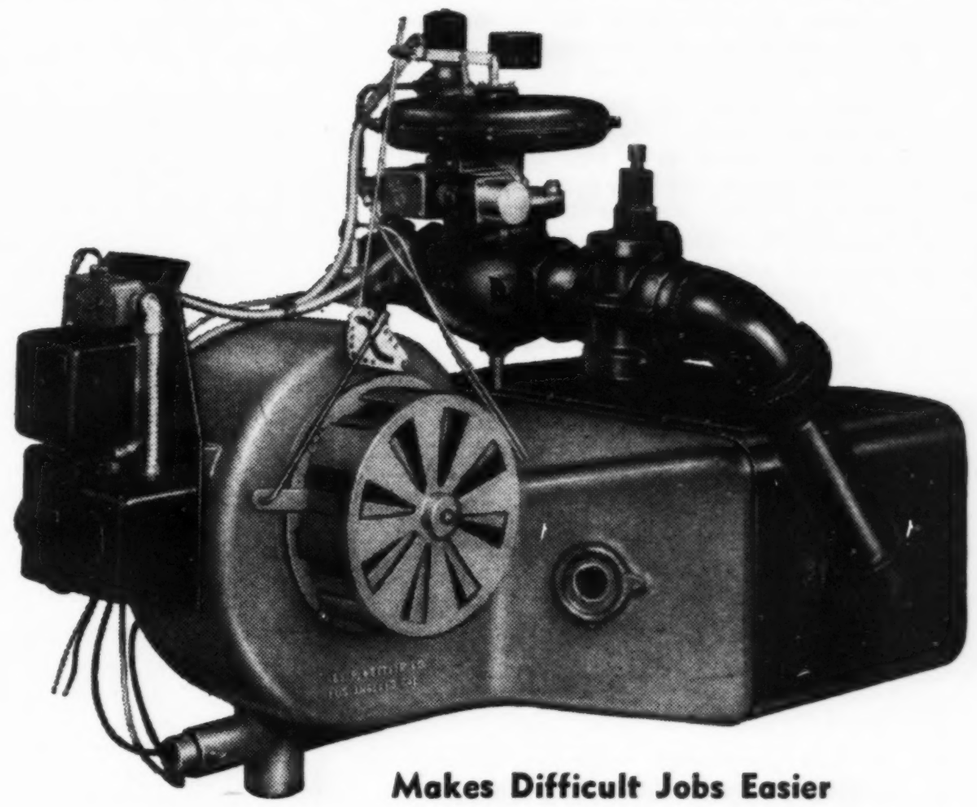

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WILLIAM J. WUESTENFELD has been elected president and general manager of North Shore Gas Co., Chicago, succeeding A. W. Conover (April *GAS*, p. 62). Mr. Wuestenfeld was serving as a vice president of North Shore. Before joining the company four years ago, he served in executive capacities with gas and electric utilities in Davenport, Ottumwa, and Muscatine, Iowa.

E. HOLLEY POE, natural gas consultant, recently became a general partner in Edward W. Ackley & Co., 30 State St., Boston. Mr. Poe will specialize in oil and natural gas securities.

L. L. BAXTER, president of the Arkansas Western Gas Co., Fayetteville, Ark., has been named by Gov. Sidney McMath a member of the Arkansas Resources & Development Commission.

- OBITUARIES -

JOHN VAN NORDEN, 55, secretary and sales promotion manager of American Meter Co. Inc., New York, died on March 17. Mr. Van Norden, who joined the company in 1928, was a member of the executive board and committee of the AGA, treasurer and director of GAMA, member of the Southern and New Jersey gas associations, a founder-member of the Society of Gas Operators, and clerk of the Gild of Ancient Supplers. Before his association with American Meter, Mr. Van Norden was a partner in the Hal-Nord Newspaper Feature Service and was in the advertising department of McGraw-Hill.

John Van Norden

B. B. FERGUSON SR., 72, who rose from clerk to president of the Portsmouth (Va.) Gas Co., died recently shortly after undergoing an operation. Mr. Ferguson was an active AGA member and was a past president of the Southern Gas Assn.

JOSEPH T. GRIFFITH, 50, assistant secretary of the Arkansas Natural Gas Co. and Arkansas Louisiana Gas Co., died Feb. 11 in Shreveport after a three-week illness. Mr. Griffith was a member of the AGA and the Mid-Continent Oil & Gas Assn.

ROBERT T. ARMISTEAD, 88, retired engineer for the Richmond, Va., City Gas Works, died April 4. Mr. Armistead retired five years ago, having been employed by the city for 50 years.

HAROLD E. ROOT, 46, assistant secretary of the Binghamton (N.Y.) Gas Works, died March 25. He had been associated with the company for 20 years, as senior accountant since 1944.

A. H. WARREN SR., former vice president and general manager of the Houston Gas & Fuel Co., United Gas Corp.'s predecessor, died recently at his home in Pensacola, Fla. Mr. Warren was manager of Stone & Webster properties in Galveston for many years. Prior to his retirement in 1941, he served as assistant to the president of United Gas in Shreveport.

LUTHER S. WILLIAMS, who was president of The Harrisburg (Pa.) Gas Co. at the time of his retirement in 1930, died on March 26. Mr. Williams entered the gas business in 1886 with the United Gas Improvement Co. in Paterson, N. J. He was a charter member and first president (1909) of the Pennsylvania Gas Assn.

HARRY C. PALMER, former president of the Iroquois Gas Corp., Buffalo, N. Y., and one of the early leaders of the gas industry in western New York, died March 16. He was 79. Mr. Palmer served Iroquois and its predecessors from 1905 until his retirement in 1934. He became president of the company in 1929.

NORWOOD JOHNSTON, 85, a pioneer in the natural gas industry in Pittsburgh, died March 8. Mr. Johnston was superintendent of Manufacturers Gas Co. when the first natural gas lines in the district were built, and for many years he was vice president and general manager of Carnegie Natural Gas Co. He retired some years ago.

JACOB T. BARRON, vice president of the Public Service Electric & Gas Co., Newark, N. J., died on March 12. The 65-year-old gasman had joined the firm in 1907 and rose through various positions to become a director and vice president in charge of operations.

LEO J. SULLIVAN, 60, superintendent of the individual gas sales department of Rochester (N.Y.) Gas & Electric Corp., died Feb. 7. He joined the gas company in 1913 following his graduation from Cornell University.

ERNEST M. HENDERSON, 62, a retired office supervisor for Pacific Gas & Electric Co., died March 5. Mr. Henderson had been with PG&E at Fresno, Calif., for 25 years. He retired in 1946.

EMIL F. LUEDTKE, 57, superintendent of operations for Home Gas Co. (Binghamton, N. Y.) in Minneapolis, died recently at Willmar, Minn. He had been employed by the firm for 18 years.

JAMES MAXWELL ELLIOTT, for the past 20 years purchasing agent for Atlanta Gas Light Co., died April 2 after a long illness.

A.P. KING, 64, superintendent for United Gas Corp., Shreveport, died March 28 after an extended illness.

First Natural Gas Comes To Eastern Tennessee

By ARTHUR B. ALLYNE

THE current year will see fulfillment of the vision of a group of men who have been trying for years to bring natural gas to east Tennessee. The completion of the 22-in. line from Greenbrier, Tenn. to Oak Ridge in December 1949 marked the initial link in a broad pipeline network; the fall of 1950 will bring this modern fuel for the first time to residential, commercial, and industrial markets in Columbia, Mount Pleasant, Tullahoma, Chattanooga, Cleveland, Alcoa, Knoxville, and numerous other towns in east Tennessee. The main transmission lines that will accomplish this result, as well as the proposed extension of the system on to Kingsport and Bristol, Tenn., are shown by the accompanying map.

Exclusive

East Tennessee Natural Gas Co. was incorporated in April 1947 and in August 1948 merged with the Trans-Tennessee Natural Gas Corp. Officers of East Tennessee are Wade V. Thompson, president; Frank M. Cantrell, chairman; Herbert S. Walters, executive vice president; Franklin T. Rainey, vice president and manager of operations; and Rhoton P. Clift, vice president.

The company's headquarters are located in Chattanooga, with construction offices also located in Knoxville. Plans have been announced for constructing a $150,000 operating headquarters in that city this year.

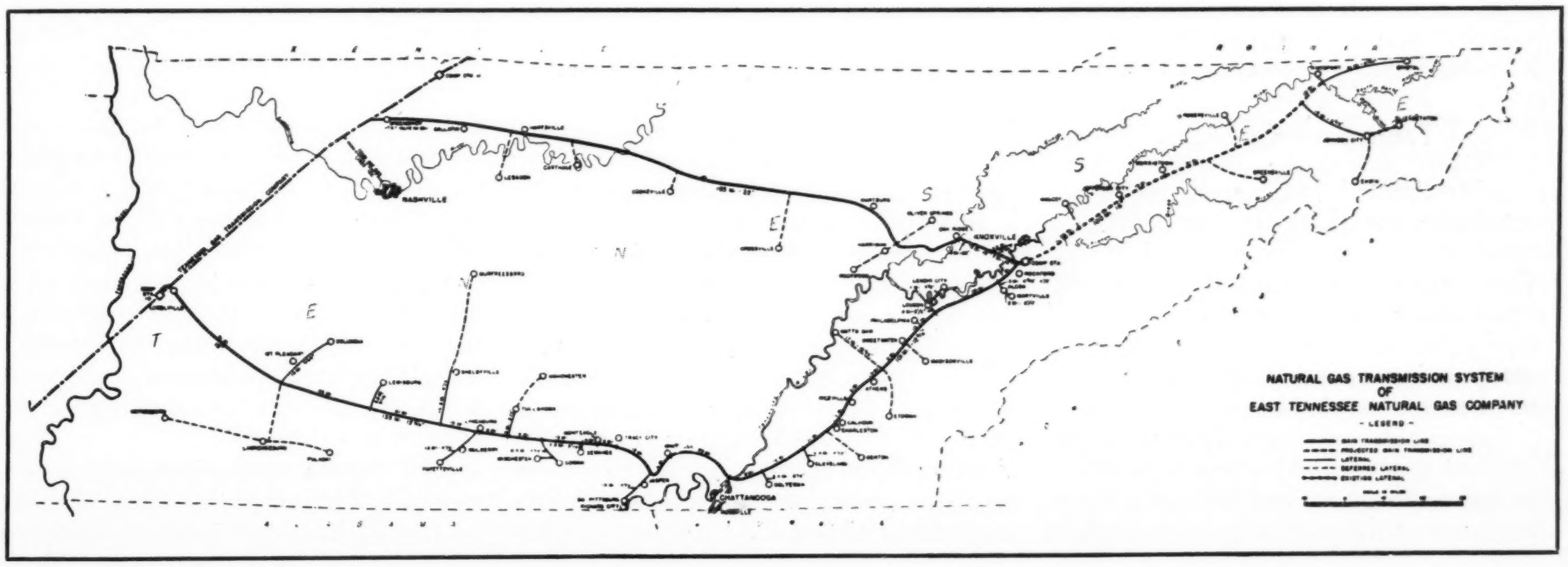
In February 1948, the Federal Power Commission in its Docket G-889 issued East Tennessee a certificate to construct and operate the so-called Lobelville-Chattanooga-Knoxville system together with certain lateral lines. Due to the lack of steel pipe and other materials, the company has had to delay construction of this portion of the system until 1950. Subsequent amendments to the original FPC certificate now provide that construction shall begin no later than April 1, 1950, the line to be completed to Chattanooga no later than Oct. 1, 1950.

In the meantime the Atomic Energy Commission had evinced an interest in a natural gas supply to serve its nuclear plants at Oak Ridge and negotiated a contract with East Tennessee for the delivery of 60 MMcf of gas per day, subject to FPC approval. In its order in Docket G-1065 the FPC issued a certificate to East Tennessee to construct and operate the Greenbrier-Oak Ridge line in May 1949.

The source of gas for both of these lines is the Tennessee Gas Transmission Co.'s main line passing through Tennessee slightly west of Nashville. Tennessee Natural Gas Lines Inc., which serves Nashville and likewise receives its gas from TGT, was organized by the founders of East Tennessee Natural. Mr. Thompson was also among the original

Mr. Allyne is consulting engineer, Ebasco Services, Inc., New York.

MAP BELOW shows the two East Tennessee lines running to the Chattanooga and Knoxville areas.



proponents of Tennessee Gas Transmission Co.

The Greenbrier-Oak Ridge line terminates at a point less than 30 miles from Knoxville, which is the terminus of the Lobelville-Chattanooga-Knoxville line. Because of the several advantages which would result from the interconnection of these two lines at their terminus, East Tennessee applied for authority of the FPC in 1949 to build the so-called "Tie-line." In its findings in Docket G-1272, the FPC authorized its construction and operation in November 1949.

Coal Country

For a number of years TGT's lines running through Tennessee in a northeasterly direction west of Nashville have more or less divided the natural-gas-fed western third of the state from east Tennessee, which has been depending in the main upon coal as its major fuel. The bringing of natural gas into east Tennessee, where TVA power has long been available, is expected to give new impetus to the swing of industry to the South.

The primary purpose of the Greenbrier-Oak Ridge pipeline was to serve AEC plants at Oak Ridge. The 22-in. line has far greater capacity than the 60 MMcf per day contracted for to date, however, and some part of this excess capacity will be available for towns and industries farther east. The Lobelville-Chattanooga-Knoxville line will serve numerous chemical plants, cement plants, textile, and other industries along its route as well as the government's new air research base at Tullahoma, the giant aluminum plants at Alcoa, and the cities of Chattanooga and Knoxville. There are more than 400 manufacturing plants in the Chattanooga area and 300 in the vicinity of Knoxville.

Gas capacity in the two main lines is also sufficient to supply the expected markets along the route of the proposed Knoxville to Bristol extension planned for 1951. This line would likewise serve large industrial and manufacturing chemical plants as well as Morristown, Johnson City, Kingsport and Bristol.

Transport Capacity

It is estimated that the peak day send-out during the fifth year of system operation will be approximately 166 MMcf. The corresponding total system capacity, assuming the same distribution of loads, is 183 MMcf per day without compression on the system, except for the Knoxville-Bristol line.

Gas is received from TGT at Greenbrier at around 550 psi and is available at Lobelville at around 750 psig. From a glance at the system map one might

Arthur B. Allyne

well ask why a single west-east line should not be built instead of two. There were two reasons why this was not done. First, for reasons of national security, the Atomic Energy Commission wished a line to be built to Oak Ridge whose primary and initial purpose was to assure AEC a continuous supply of gas. Second, while a large part of Tennessee is rocky, the area between the two main lines is particularly so, and the cost of a single line through the heart of the so-called "Nashville dimple" would have been tremendous.

The Greenbrier-Oak Ridge line runs 165 miles across east Tennessee and passes through some of the most rugged pipeline country in the U.S. It was built by Oman Construction Co. of Nashville in association with the R. H. Fulton Co. of Lubbock, Texas. Design, engineering and supervision of construction of the line was performed by Ebasco Services Inc., New York.

A Rugged Inch

Although the line is not spectacular with respect to size or length in these days of pipeline giants, it did present some "interesting" problems in construction not normally encountered. The territory traversed is an almost continuous series of mountain ridges interspersed with rock ledges, streams, rivers and mountain roads. In the 165 miles it was necessary to cross 143 streams and rivers, 220 roads and highways, and seven railroads. Much of the right-of-way proved to be almost solid rock which made it necessary to blast out more than 126,000 cu yds of rock during the course of construction. In some of the mountain passes it was necessary to resort to side-hill construction on slopes of up to 70°, and also to employ rock beds of streams for ditch where canyons were too narrow to provide ordinary right-of-way. In climbing the Highland Rim, east of the Cumberland river, the only feasible route was a canyon occupied by Flynn's creek. In this 10-mile stretch it was necessary to cross the creek 27 times, and in some cases to utilize the bed of the creek for ditch, which required ditching through solid rock. Some 300 cast iron river weights were utilized in this section alone to eliminate the danger of winter floods floating out the line. Some of the photographs which accompany this article illustrate these construction difficulties.

The construction of the line began in the last week in June of 1949 and it was placed in service 184 days later—Jan. 2, 1950. One big-inch spread kicked off at Greenbrier on June 28. Unexpected quantities of rock as well as almost continuous rainfall throughout the summer months necessitated the use of two additional big-inch spreads which were activated in September and October. Some idea of the roughness of the country can be gathered from the fact that the bends average between 55 and 60 per mile or roughly one every other joint of pipe.

Some engineering features of the line may be of interest. Advantage was taken of the navigable rivers which exist in this part of the country, and as a result it was possible to barge the entire 30,000 tons of 22-in. steel pipe to the job site by scheduling barge shipments sufficiently in advance to allow for the two- to three-week trip.

Automatic Shut-offs

All main line valves are 20-in. cylinder-operated automatic plug type, spaced at an average interval of 12 miles. To protect the entire installation against vandalism and the automatic cylinders from dust and the elements, each main line valve installation is housed in an 8-ft x 10-ft prefabricated steel building. The automatic shut-off mechanisms in the main line valves have been so adjusted that a serious break at any point 15 miles on either side of the particular valve will cause both valves in that section of line to close and thereby isolate it until repairs can be made. If a main line break does occur in the western portion of the line, Oak Ridge should be able to live on line pack until the repair is made. In order to minimize the danger of sabotage and washouts, the entire line was buried, no exposed spans being permitted.

Drips made from sections of 22-in. pipe were installed at eight points along the line, selected to be approximately 5 and 10 miles downstream respectively from the sites of four possible future compressor stations.

The Cumberland river was crossed near the old Fort Blount ferry by means of two 22-in., ½-in.-wall straight lines

laid 50 ft apart, connected with common headers and equipped with four 20-in. valves. The Cumberland river has a smooth solid rock bottom and is subject to severe flooding during the winter season. For this reason, it was decided to bury the two lines in 4-ft ditches for the entire 350-ft wide crossing. The two ditches were drilled and shot individually, with some 17,000 lb of dynamite being required.

Crossing the Rivers

Because of the construction difficulties involved in river crossings in this part of the country, the normal practice of using pipe of a smaller size than main line pipe for a multiple crossing was not followed. The two lines across the river were kept at 22-in. so that in the event a second line is ever laid along the same right-of-way it will not be necessary to lay a third line across the river.

In providing for proper submergence of the Cumberland river crossing, consideration was given to the possibility of putting the additional weight required in steel wall thickness. A study of costs, however, indicated a slight advantage in favor of ½-in. wall pipe plus cast iron river weights on 15-ft centers.

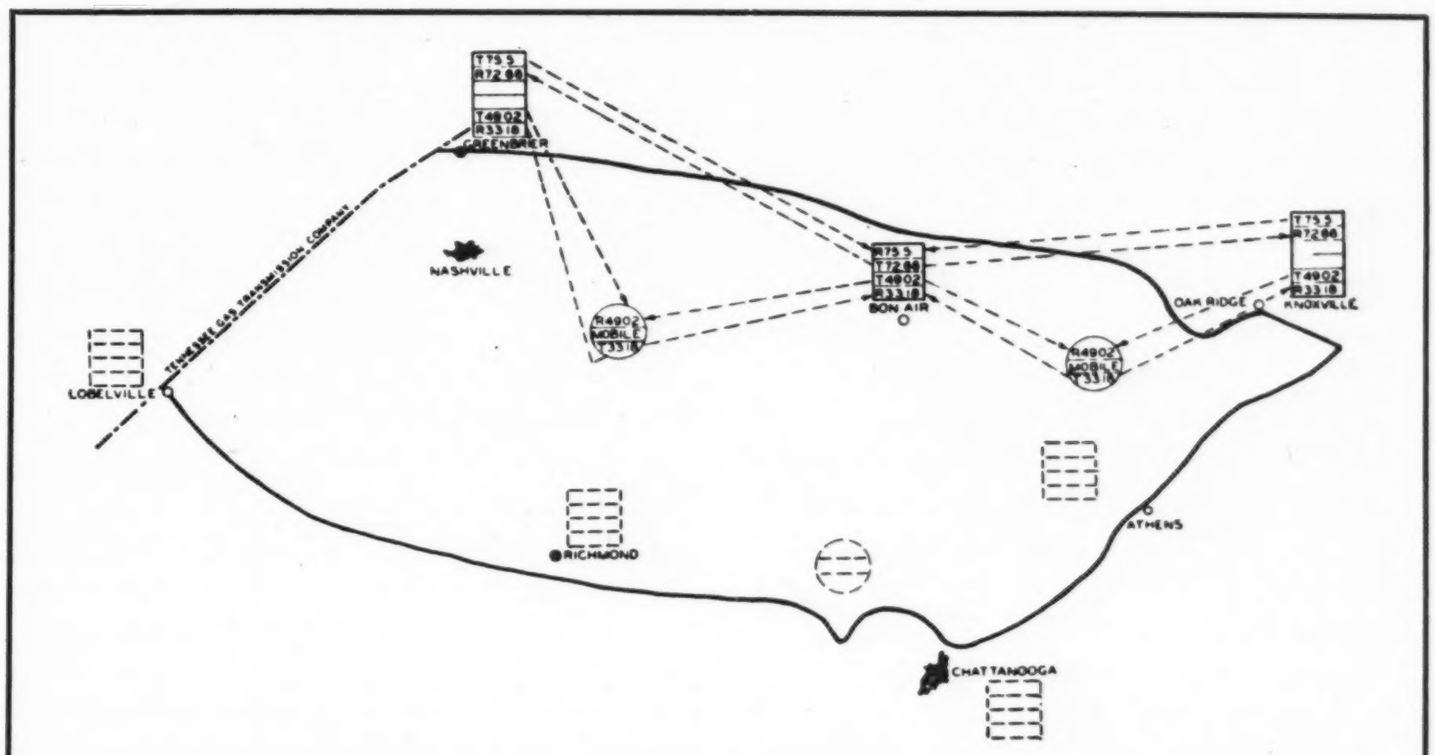
There are about ten communities along the route of the line which may desire gas service in the future and, accordingly, 3-in. taps and valves were strategically located along the line for this purpose. Three meter stations have been provided within the restricted area at Oak Ridge to serve the governmental facilities.

Testing The Line

At the point of take-off from TGT lines at Greenbrier, an automatic flow-controller receiving station has been built. Also at Greenbrier are a six-room modern residence, three-room office, and radio station, operated by the company's representative stationed at that point.

Upon completion of construction the entire line was tested to 720-lb pressure by taking the gas available at Greenbrier at around 530 lb and packing the line with the aid of a 350-hp portable Clark compressor made available through arrangement with the Texas Eastern Transmission Corp. A period of about three days was required by the compressor located at Greenbrier to bring the entire line up to the test pressure. After shutting off the compressor the line was then kept at this pressure for a total period of approximately 48 hrs before being placed in service on Jan. 2.

Some skepticism was voiced during construction of the line as to its operating efficiency since its capacity was originally computed by means of the so-called "Panhandle formula." This doubt was apparently based on the roughness of the territory through which the line must pass. Operating data collected at this writing, however, indicate that the line is actually exceeding the earlier estimates of efficiency of 92%. Undoubtedly contributing to this high efficiency is the fact that no wrinkle bends or mitred joints were permitted during construction.



SCHEMATIC DRAWING showing East Tennessee's radio communication system, present and proposed. Squares show transmitting and receiving frequencies for land stations—circles show similar information for mobile units.

J. T. Brodie was in charge of work for Oman Construction Co., assisted by B. A. Carrigian and M. L. Boyd, spread superintendents. Key Ebasco personnel engaged on the line were E. K. Wilkins, construction manager; the writer, assistant construction manager; R. W. Tirrell, mechanical project engineer; W. H. Hitchcock Jr., construction superintendent; G. van B. Slagle, resident engineer; P. G. Delaney, chief inspector; D. H. Futrell, field purchasing agent.

Corrosion

Cathodic protection for the prevention of corrosion is included in the plans for the Greenbrier-Oak Ridge line as well as all other lines on East Tennessee's system. During construction of the Oak Ridge line, Shepard Rod readings were taken at intervals of 500 ft throughout the length of the line to provide a soil resistivity map. Coating resistivity tests were also made on sections of the completed line after considerable intervals of time during which the backfill was subject to rainfall and settling. A combination of these tests formed the basis of determination of cathodic protection requirements.

Although the greater part of the line was found to traverse soils having resistivities above 10,000 ohm centimeters, many short areas were encountered where readings well below 1000 were obtained. Strangely, the most corrosive soils found were in some of the rockiest areas. These soils were in evidence as seams of clay in rock formations.

Insulating flanges were installed in the main line at approximately 20-mile intervals. At each insulated flange, test points were installed in such a manner that the flange can be short circuited to give flexibility to any cathodic protection system employed. In addition test points are installed along the the line at approximately five-mile intervals to permit easy measurement of degree of protection being attained after installation of cathodic protection.

System Design

Based on detailed tests, a decision was reached to use rectifiers throughout the line with the exception of the portion within the reservation at Oak Ridge. Within the reservation the Atomic Energy Commission requested that magnesium anodes be used. Although the current requirements for the entire line are only in the order of 10 amperes or less, rectifiers were found to be the most economical source of current. The reason for this was that high resistivity soils were encountered in practically all areas sufficiently rock-free to permit installation of anodes or rectifier ground beds.

The complete system as finally designed consists of one 12-volt, 10-amp rectifier; three 24-volt, 10-amp rectifiers; and one magnesium anode installation with a planned capacity of 1.5 amps. The four rectifiers will be used to protect approximately 40 miles per rectifier, with the balance of the line being protected by the single magnesium anode installation.

The ground bed to be used with the 12-volt rectifier will be of the vertical anode type consisting of five 10-ft

lengths of 2-in. scrap steel pipe placed in 8-in. diameter auger holes and backfilled with coke breeze. Ground beds for the three 24-volt rectifiers will be of the horizontal type and will have cores of 2-in. scrap steel pipe at approximately 3.5-ft depth backfilled with coke breeze having about one square foot cross section. The steel pipe core will be paralleled with an insulated copper wire header in the dirt backfill above the coke breeze; this header will will be connected to the steel pipe core at intervals of about 20 ft. The length of these horizontal beds will vary from 200 to 240 ft. Although soils at most locations where power for rectifiers is available are of high resistivity, all locations tested were found to have even higher resistivity underlying soil (probably rock). This condition dictated the use of horizontal type ground beds in all cases except one where a relatively deep and moderately low resistivity soil was found. All rectifier ground beds are to be located off the pipeline right-of-way with the nearest part of each bed approximately 100 ft from the line.

The magnesium anode installation inside the AEC reservation is also to be of the horizontal type. This installation will be 400 ft long and will be parallel to the line and 25 ft from it on the pipeline right-of-way. A continuous length of 1.375-in. diameter magnesium rod with iron wire core will be used. This rod will be placed in 50-50 clay-gypsum backfill with square cross sectional area approximately 6 in. on a side. An insulated copper header wire will be buried in the trench above the anodes and connected to the anode rod at intervals in order to distribute the current load more evenly and promote uniform anode consumption.

Use of Radio

Throughout the East Tennessee system the principal means of communication for dispatching of loads and operating and maintenance functions will be radio. Because of the remoteness of a good portion of the country through which the company's lines must pass, this form of communication is by far the most flexible and dependable. The accompanying diagram is a schematic sketch of the radio communication system as installed for the Greenbrier-Oak Ridge line and as tentatively planned for the Lobelville-Chattanooga-Knoxville portion of the system. To date three land stations at Greenbrier, Bon Air, and Knoxville are in service, and 12 mobile units are installed in the company's cars and trucks.

The Knoxville station is installed at the company's operating headquarters, where dispatchers are on duty around the clock. In case of line break, repair operations will also be coordinated from the same point.

Referring to the figure, the Knoxville and Greenbrier land stations are similar in nature, the equipment consisting of one Type 250 UFS, 250-watt 49.02-mc main station transmitter and 33.18-mc main station receiver unit for direct communication with mobile units operating within range of these stations, and one Type 1498, 50-watt fixed station, 75.5-mc transmitter and 72.66-mc receiver unit for communication with the relay station located at Bon Air. The Bon Air station is an unattended automatic relay station, the equipment consisting of similar Type 250 UFS, 250-watt 49.02-mc main station transmitter and 33.18-mc main station receiver unit for direct communication with mobile units operating within range of this station and one Type 1505 fixed station 250 watt 72.66-mc transmitter and 75.5 mc receiver unit for communication with fixed land stations at Knoxville and Greenbrier. This station comes into action on signal from the terminal stations or from the mobile units, so that it is possible to communicate between two mobile units anywhere along the entire line, provided they are within range of one of the three land stations.

Station Replacement

The Bon Air station is located on a high mountain top and was so placed with the thought that it will fit into the overall plan of equipping the Lobelville-Chattanooga-Knoxville system with radio communication in 1950, upon receipt of FCC approval. All equipment was installed by the Link Radio Corp. The equipment at each of the three stations is installed in separate prefabricated steel buildings with remote console units being installed in the operating headquarters at Knoxville and in the receiving station office at Greenbrier to monitor these two terminal stations. Radio towers are self-supporting Wincharger units 80 ft high, having an 18-ft extension mast, bringing the total tower height to 98 ft. Directional antennae are installed atop each tower for the two wave bands emitting from each station.

The two-way radio equipment installed in the mobile units are Type 75 FMTR-75, two-way 75-watt, 33.18-mc transmitting and 49.02-mc receiving units. Leece Neville alternators replace generators furnished as standard automotive equipment.

It is planned to complete the construction of the entire Lobelville-Chattanooga-Knoxville network during the construction season of 1950. As the system map indicates, this program involves the construction of some 300 miles of 16-in. and 12¾-in. main line and approximately 100 miles of laterals. Contracts have been let to the Oman Construction Co. of Nashville and the N. A. Saigh Co. of San Antonio, Texas, for this work. It is expected that natural gas will be available to Knoxville by June 1 and to Chattanooga by July 1 of this year. Work has started on six river crossings between Oak Ridge and Chattanooga, including two crossings of the Tennessee River.

1950 Prospects

All of the main line pipe is on order and shipments by barge are expected to be complete by early summer. Main line valves will be spaced at about 12-mile intervals with every other valve being automatic in operation. The crossing of the Tennessee river at Chattanooga will be made by two 10¾-in. lines connected by headers to the 12¾-in. main line. The site selected for the crossing is just below the Chickamauga dam. Other river crossings are of lesser magnitude and will be single lines without valves. These crossings will all be straight lines buried in 3-ft ditches.

Also during 1950 East Tennessee plans to construct an operating headquarters on U. S. Highway 70, west of Knoxville. The company has acquired a 35-acre tract of land for this purpose. The tie line passes through this property as well as the start of the lateral to the city of Knoxville.

If present plans materialize, the company intends to further extend its transmission network by the construction of the Knoxville-Bristol link in 1951. This extension will consist essentially of 100 miles of 16-in. line and some 50 miles of smaller lines to serve the towns and industries in this portion of the state. Before proceeding with this expansion, however, East Tennessee must obtain approval of the FPC. The estimated cost of the entire East Tennessee system is approximately $26 million, based upon current material and labor costs.

Acknowledgment is made of the valuable assistance given by R. W. Tirrell, mechanical project engineer, and A. W. Peabody, corrosion engineer, both of Ebasco Services Inc., in preparation of material utilized herein.

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PROGRESS ON THE PIPELINE: 1950

On the opposite page are the routes of all the pipelines reported by the major companies as projects to be undertaken or completed this year. Map numbers are keyed to the progress reports on this and the following pages.

1. NORTHERN NATURAL GAS CO. has crews at work on its 1950 project, which includes 597.1 miles of loops, two new compressor stations, and additions to seven others. Capacity will be boosted to 600 MMcf daily, starting late in October, the estimated date of completion. Expenditures will total $51.8 million. R. H. Fulton & Co., Lubbock, Texas, started right-of-way work in March on the sections of the looping it will build, and expects to start construction this month. Fulton will build 155 miles of 20-in. main line from Garden City to Bushton, Kan.; 40.2 miles of 26-in. north of Skellytown; 74.9 miles of 26-in. line north of Beaver, Okla.; 33.5 miles of 26-in. north of Mullinville, Kan.; and 72.5 miles of 26-in. north of Bushton, Kan.

Midwestern Constructors Inc., Tulsa, has a contract for two sections of Northern's new line, and will begin work in July. Midwestern will build two 26-in. lines, one 43.4-mile section between Palmyra, Neb. and Oakland, Iowa, compressor station; the other, a 65.9-mile project commencing at Oakland station and continuing northeastward along the Northern line.

R. B. Potashniek, Cape Girardeau, Mo., will build three 26-in. sections: one is to be a 31.2-mile stretch from the vicinity of Belmond, Iowa, to vicinity of Ventura compressor station; the second is 41 miles from vicinity of Forest City, Iowa, to vicinity of Wells, Minn.; and the third is 39.5 miles from Owatonna, Minn., to Rosemont, Minn.

2. EL PASO NATURAL GAS CO. will have its 800-mile looping of the Texas-California line completed in October. Still uninstalled on the line are sections of pipe from northwest of Benson, Ariz. (68 miles), east of Lordsburg, N. M. (43 miles), east of Deming, N. M. (25 miles), east of El Paso (32 miles), and in the Permian basin (22 miles). The 102-mile section of the line between Topock, Ariz., on the California border, and a point near the Maricopa (Ariz.) county line, is in progress now and will be completed in June.

El Paso also plans a 451-mile, 24-in. line from Blanco, N. M. to Franconia, Ariz., to be started this year. The line would have laterals to Gallup, N. M., and Holbrook, Winslow, and Prescott, Ariz. A 24-in. line in Yoakum and Hockley counties of Texas (36.6 miles long) has been proposed for this year, as has a 120-miles, 12¾-in. line from a point northwest of Odessa to Snyder, Scurry county, Texas. El Paso also seeks FPC approval of a plan to increase deliveries to Phoenix, Ariz., under which project it would build about 44 miles of line and exchange segments of line with Central Arizona Power & Light Co.

3. TEXAS GAS TRANSMISSION CORP. will build four new compressor stations in 1950, which will aggregate 28,080 hp and will bring the company system capacity to 600 MMcf daily. The compressors will be spotted along Texas Gas' new line from Carthage field to Middletown, Ohio, at Bastrop, La.; Clarksdale, Miss.; Covington, Tenn.; and Calvert City, Ky. Texas will also build a 32-mile lateral from Slaughters, Ky., to Evansville, Ind., this year, and a 9-mile, 20-in. line in the Carthage gas field.

4. TENNESSEE GAS TRANSMISSION CO. has contracted with the following companies for work on its 1950 projects: Oklahoma Contracting Corp., Dallas—103 miles of 30-in. and 26-in. loops from Premont, Texas to El Campo; 91 miles of 30-in. from Holly Springs, Miss. south along Tennessee's existing line; H. C. Price Co., Bartlesville—63 miles from point near Youngstown, Ohio southwestward on Tennessee line, 63 miles from Muskingum river northeastward, 47 miles from Muskingum river southwestward, 47 miles from north bank of Ohio river near Portsmouth extending northeastward. All Price jobs will be completed this fall.

Latex Construction Co., Houston, will build three sections for Tennessee: 123 miles of 30-in. line—90 miles from West Monroe, La., to Many, La., and 30 miles from Jones, La., to the Mississippi river. Other sections will be 54 miles of 16- and 12-in. line from Kinder, La., to Grand Chenier, La., and 95 miles of 20-in. line from Natchitoches, La., to Kinder. Work got under way last month.

In all, Tennessee Gas has the following projects planned for this year: 526 miles of 30-in. line and 100 miles of 26-in. line paralleling its existing system in several states. Ten compressor stations will be enlarged and 54 new compressor units aggregating 68,480 hp will be added. A 385-mile main-line extension of 26-in. line will be laid from Greenup county, Ky., across Ohio and Pennsylvania to Buffalo (this includes a 32-mile, 16-in. lateral from Bessemer, Pa., to Pittsburgh). Tennessee has applied for still another new line—from Buffalo across New York state to the Massachusetts border near Albany. The company recently received FPC approval of a proposal to replace existing facilities across the Mississippi river at Greenville with four 26-in. pipelines.

5. ARKANSAS LOUISIANA GAS CO. is building a 20-in., 161-mile line from Waskom, Texas to Malvern, Ark. Anderson Bros. Construction Co., Houston, was able to make no progress on the line last month because of poor weather, but will go ahead with the job as soon as conditions warrant. The line is a portion of the line scheduled for completion last winter from Magnolia, Ark. to Waskom—weather and the steel strike allowed completion of the Magnolia-Malvern section only at year's end. A compressor station with initial hp of 4200 is scheduled for construction northeast of Waskom.

6. KANSAS-NEBRASKA NATURAL GAS CO. INC. reports the following projects for 1950: Field gathering lines in Hugoton field to be built to connect proposed new wells to be drilled, 10 miles of 12¾-in. from Thomas-Rawlins county line in Kansas and extending northward, a lateral from west of Kearney, Neb., to Litchfield and Ravenna—14 miles of 2, 3, and 4-in. line. Work will start immediately.

7. MICHIGAN GAS STORAGE CO. will have E. J. Mahoney Contracting Co. at work this summer on a 46-mile, 22-in. line east of Ovid, Mich., to a point east of Mt. Pleasant, Mich. Cost of the line is estimated at $2.5 million.

8. TEXAS ILLINOIS NATURAL GAS PIPELINE CO. will start construction of its 1300-mile, $150-million line from the Texas Rio Grande valley to Joliet, Ill., late this year, with completion scheduled for 1951. Initial capacity of the line (the third Peoples Gas Light & Coke Co. line from Texas to Illinois) will be 300 MMcf, with increases to 500 MMcf proposed for the future.

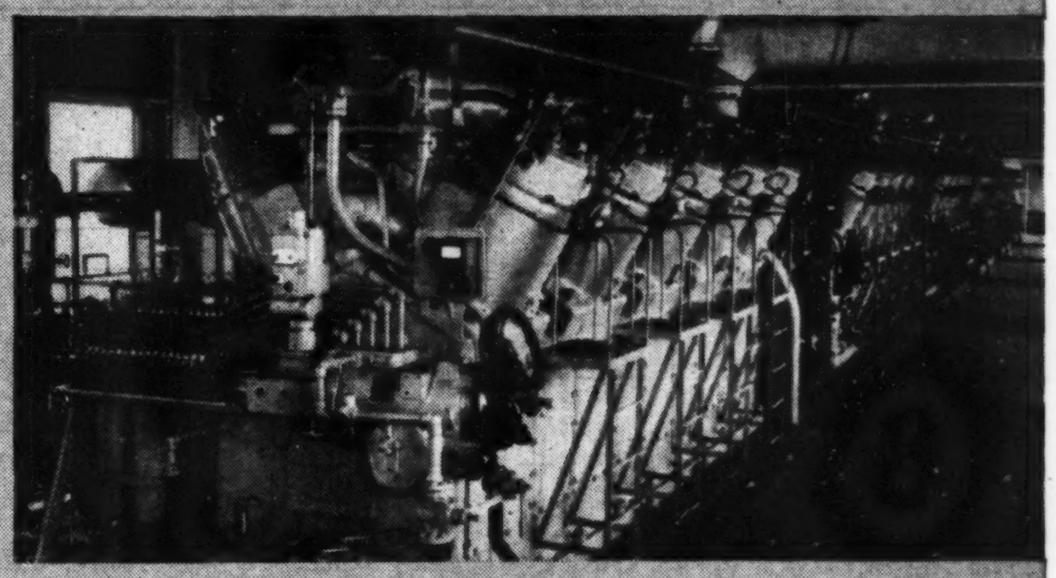
9. TEXAS EASTERN TRANSMISSION CORP. has plans for New England—with a line that would start at Lambertville, N. J. and head northeastward through New York, Connecticut, Rhode Island and Massachusetts to Boston, with laterals to Concord, N. H. and New Bedford, Mass. In order to send the gas north to serve New England, Texas Eastern's loops of 30-in. line from Lebanon, Ohio to Connellsville, Pa. (about completed) would be used—gas would thence be transmitted through existing lines to Lambertville, N. J. An additional 49,200 hp would be installed on the system to do the job. Additional capacity that would bring the company's total

HORSEPOWER . . . hub of Stanolind's unique, multi-purpose operation in the Hastings field

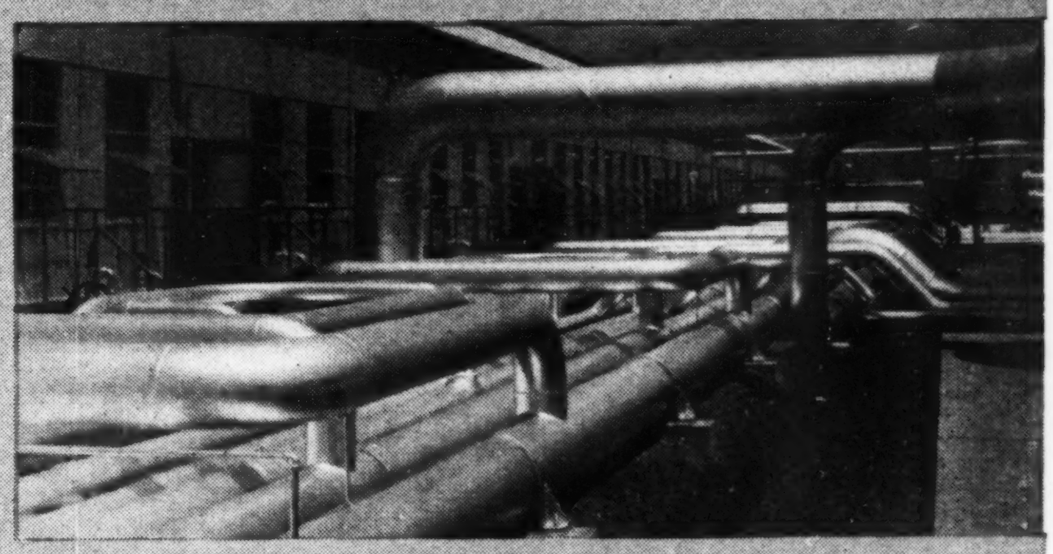
Twelve (12) modern Cooper-Bessemer GMV compressors shoulder an unusual multi-purpose job in Stanolind Oil and Gas Company's big, new, Hastings plant. This includes gas compression not only for natural gasoline processing, but for gas lift work in the field and underground storage as well.

All told, there are five stages of compression, from vacuum to a maximum of 5,000 psi — believed to be the widest compression range within the industry to date. Here also is the first application of underground residue gas storage in the Texas Gulf Coast area.

In this compressor installation, extreme flexibility is one of the prime essentials. The Cooper-Bessemer V-angles have a long and outstanding record of flexibility, adaptability to widely varying demand in pressure and flow. For that matter, you'll find these modern units to be outstanding in *many* ways . . . always adding up to efficient, dependable performance at low cost!



Engine view of 10 cylinder 1000 hp GMV compressor units from crank-door side showing V-type design, ignition and auxiliary lubrication equipment.

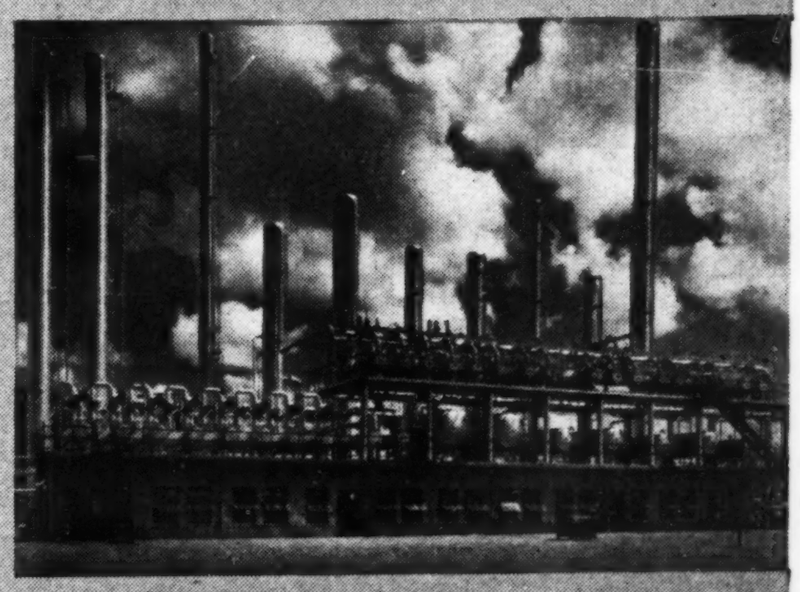


Low pressure manifolding for wet gas system. Block valves permit separation of system into two complete parts with separate inlet scrubbers, coolers and separators.

Six of nine 1000 hp GMV's handling wet gas into the Stanolind Oil & Gas Company's Hastings gasoline plant for processing. Each unit has 4 compressor cylinders for 3-stage compression from vacuum to 715 psia, handling 30 to 40 million cu. ft. per day. Units have semi-automatic, pneumatically operated unloading.

Foreground: Three 800 hp GMV's raise residue gas pressure through the first stage to 1570 psia or through the second stage to a discharge pressure of 3515 psia to 5000 psi maximum, with a capacity range up to 26½ million cu. ft. per day.

Three-story distillation structure shows coolers, main oil exchangers, accumulators, and enclosed pump room. The 10-cylinder GMV's deliver wet gas to absorbers at extreme left.



by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Houston, Dallas, Greggton, Pampa and Odessa, Texas Tulsa Shreveport St. Louis Los Angeles

Tennessee Gas Transmission Co., Houston, which is now getting under way on the job of extending its line toward Buffalo, N. Y., has been bolstering its main transmission line with a 30-in. loop. In this photo, crews from Morrison Construction Co., Austin, Texas, battle bad weather and deep mud to lay a 90-mile stretch near Springfield, Tenn. An International TD-24 diesel crawler tractor, equipped with matched Superior sideboom, handles the pipe as it is made ready for lowering.

to 940 MMcf daily is included in the proposal. FPC has applications on the line, but not much hope is held for approval before 1951.

Meanwhile, Texas Eastern is building in Texas—115 miles of 16-in. from Baytown to Provident gas field, and 33 miles from Baytown northeastward to Hankimer. Associated Pipe Line Contractors, Brown & Root, Inc., and O. R. Smith are on these latter jobs for Texas Eastern.

10. NEW YORK STATE NATURAL GAS CORP. has the following projects scheduled for this year: 1½ miles of 16-in. line near Genessee township, Potter county, Pa. to be completed May 20; 26 miles of 16-in. loop line from Colvin station, Fallowfield township, Pa. to Murraysville, Westmoreland county, Pa., to be completed in September; 20,000 ft of 16-in. line near Boom storage field, Tioga county, Pa., to be completed July 1. FPC approval has just been received for 53.5 miles of line from the NYSNG compressor station in Greene county, Pa., to one in Westmoreland county, cost of which will be $2.6 million. The approval also includes some replacement of pipe in Tioga and Potter counties, Pa. Williams-Austin Co., and Pipe Line Construction & Drilling Corp. are working on the jobs.

11. PACIFIC GAS & ELECTRIC CO. has $345 million allocated for construction of transmission facilities in 1950. This will be spent on the completion of the Topock, Ariz., to Milpitas, Calif., line, of which 425 miles remains unfinished. Bechtel-Price-Conyes are laying the 34-in. line.

12. UNITED GAS PIPE LINE CO. has Ray J. McDermott & Co. Inc., Harvey, La., at work on a 24.89-mile, 16-in. line from near St. Rose, La., along the west bank of the Mississippi river to a point opposite Chalmette. The line will be completed July 1.

13. PANHANDLE EASTERN PIPE LINE CO. will build 137 miles of loop lines this year. Midwestern Constructors Inc. will start June 1 on 69 miles of 26-in. loops in Kansas, and will complete them by Oct. 1. Anderson Bros. started April 15 on 68 miles of 30- and 26-in. loops in Missouri, Illinois and Indiana; the job will be completed about Sept. 1. Panhandle will spend a total of $17.9 million on transmission facilities this year, including the two projects listed above and added compressor hp and well connections.

14. TRANSCONTINENTAL GAS PIPE LINE CORP. will concentrate 1950 efforts on completing the remaining 685 miles of the 1485-mile Texas-New York line, and starting the delivery of gas before the end of the year. Following are the spreads at work: Schedule A (Massey Pipe Line Construction Co., Corpus Christi), near Falfurrias, Brooks county, Texas, southerly for 80 miles to Mercedes, Hidalgo county; Schedule B-1 (H. B. Zachry Co., San Antonio), 108.8 miles between Falfurrias to a point in Refugio county, Texas; Schedule B-2 (Oklahoma Contracting Corp., Dallas), from near Edna, Jackson county, Texas, 44.3 miles southerly to Refugio county; Schedule C-1 (Oklahoma Construction Corp.), from Harris-Fort Bend county line 29.7 miles to Edna; Schedule C-2 (Williams Bros. Corp., Tulsa), 85.2 miles southwesterly from Porters, Montgomery county, Texas to Harris-Fort Bend line; Schedule D (Texas Southern Contracting Co., Fort Worth), 91.7 miles from west bank of Sabine river in Newton county, Texas to east bank of Trinity river, excluding the crossing, from the west bank of the Trinity river to near Porters; Schedule E (Anderson Bros. Corp.), from Eunice, La. to Deweyville, Newton county, Texas, 81.5 miles; Raritan river crossing (Anderson Bros), three miles downstream from U. S. highway 1 in Middlesex county, N. J.; Rahway river crossing (Anderson Bros.), in Middlesex and Union counties; Susquehanna river crossing (Anderson Bros.), near Holtwood, Pa.; James river crossing (Anderson Bros.), in Buckingham and Fluvanna counties, Va.; Delaware river crossing (Anderson Bros), in Bucks county, Pa. and Mercer county, N. J.; Potomac river crossing (Anderson Bros.), west of Rockville, Md., in Montgomery county, Md. and Fairfax county, Va.; Mississippi river crossing (Kansas City Bridge Co. & Massman Construction Co., Kansas City), between West Feliciana and Pointe Coupee parishes, La.; Trinity river crossing (Texas Southern Contracting Co.), in Liberty county, Texas; Sabine river crossing (Texas Southern Contracting Co.), north of Deweyville; gathering lines in Texas, T & R Construction Co. Inc., Houston (six); Altgelt Construction Co., Corpus Christi (six), Shanks & Eustace, Alice, Texas (seven), Victoria Oil Field Maintenance Service, Victoria, Texas (five), Louisiana gathering lines, O. R. Burden Construction Corp., Tulsa (two), and Latex Construction Co., Houston (eight).

Pittsburgh-Des Moines Steel, Des Moines, has a contract for construction of a 750-ft bridge across the Brazos river near Houston and a 550-ft bridge across the Colorado river. H. C. Price Co., Bartlesville, has announced that its Somastic division has a Transcontinental contract for 40 miles of pipe-coating in eastern Pennsylvania and New Jersey.

Oklahoma Contracting Corp. will also build 23 miles of 30-in. Transcon line from Edgewater to Elizabeth, N. J. Williams Bros. will complete sections 6 and 7 of the Transcon line this summer. These sections are 30-in. pipelines from Fayetteville, Ga. to Spartanburg, S. C. T. E. Davis is superintendent.

15. JERSEY CENTRAL POWER & LIGHT CO. will complete a line from Franklin township, Somerset county, to Long Branch, N. J. by June 1. The distance is about 125 miles, and the line is being built by Thomas Proctor Co. and Construction Service Co.

16. GREAT LAKES PIPE LINE CO.'S 1950 plans include a 27-mile natural gas pipeline from Osceola, Iowa to Des Moines. Work will proceed as weather permits.

17. PUBLIC SERVICE CO. OF COLORADO has applied to the Colorado Public Service commission for permission to build a gas pipeline from the Piceance Creek field in western Colorado to Grand Junction and Rifle. The line would serve commercial and domestic customers along the route.

18. COLORADO INTERSTATE GAS CO. has asked FPC permission to construct a 175-mile, 20-in. line from the West Panhandle area of Texas to the company's Lakin, Kan. compressor station, to deliver gas to the existing Lakin-Denver pipeline. A 4800-hp compressor station would be built at the line's southern terminus. The company would complete the line in time to serve during the 1950-1951 heating season. Plan for the line is part of a larger proposal, under which Colorado Interstate would acquire all the natural gas facilities of Canadian River Gas Co.

19, 20, 21. LAKE SHORE PIPELINE CO., ERIE GAS SERVICE CO. INC., AND GRAND RIVER GAS TRANSMISSION CO. are all proposing to serve gas to eastern Ohio communities (including Ashtabula and Fairport) by constructing natural gas pipe-

lines from a Meadville, Pa., connection with Tennessee Gas Transmission's line westward to Ohio.

22. SOUTH CENTRAL ALABAMA NATURAL GAS CO. INC. has applied to FPC for permission to build a 150-mile, $2.5-million pipeline from a connection with Southern Natural Gas Co.'s line in Elmore county to the communities of Union Springs, Brundige, Troy, Elba, Enterprise, Ozark, Headland, Geneva, Florala, Opp, Brantley, Luverne, Greenville, Dothan, Andalusia, and Gantt. The line would have an initial capacity of 15 MMcf daily, and would serve about 92,000 domestic customers.

23. ALABAMA-TENNESSEE NATURAL GAS CO. will start work soon on a 75-mile extension originating at Muscle Shoals, Ala., and extending to Decatur and Huntsville, Ala.

24. MISSOURI WESTERN GAS CO. will complete 10 miles of 4-in. pipe being laid south from Archie, Mo., two miles of extension work in the city of Butler, Mo., and additional regulating facilities by Sept. 1. The company is doing the construction work itself.

25. COLORADO-WYOMING GAS CO. has Vaughn & Taylor working on a 27-mile, 10¾-in. pipeline from Mesa station to Boulder Junction, Colo.

26. PHILLIPS PETROLEUM CO. has let a contract to Vaughn & Taylor Construction Co. Inc., Wichita Falls, Texas, for 118 miles of gas gathering system (3- to 22-in.) in Sherman field, Sherman and Hanford counties, Texas. Work will start May 15.

27. MONTANA POWER CO. has crews of C. N. Deaton & Sons Inc. (Odessa, Texas) starting work on 83 miles of 12¾-in. line between Bozeman and Butte, Mont., and 21 miles of 12¾-in. from Billings south to the state line. Pipe crews got underway April 15, under C. N. Deaton, president and general manager. Hill, Hubbell & Co. (Cleveland) is pipecoating sub-contractor, and Parkhill Truck Co. (Tulsa) is stringing sub-contractor.

28. STANOLIND OIL & GAS CO. has the Carlson Construction Co., Pampa, Texas, at work on 46 miles of gathering system (6- and 8-in.) in the Hugoton field in Grant and Stanton counties, southwest Kansas. The system will supply the Hugoton 26-in. line from Grant county to Kansas City.

29. CITY OF CHARLOTTESVILLE, VA. will build 14.5 miles of 6-in. pipeline from Virginia Gas Transmission Corp.'s Doyleville metering and regulating station to its existing distribution system. The station was recently authorized by FPC and will cost $9000. The city of Charlottesville's line will cost $225,000.

30. IROQUOIS GAS CORP. has asked FPC okay of a plan to develop three underground gas storage pools (in Erie county, near Wales, and in Wyoming county, Pa.) to enlarge an existing field in Erie county, and to build 23 miles of line from the Holland and Bennington fields to other company lines. Cost of the entire project is estimated at $2.12 million.

31. ROANOKE PIPE LINE CO. will build a 30-mile, 8-in. natural gas line from a recently FPC-authorized metering and regulating station on Virginia Gas Transmission Corp.'s line near Gala, Va. to Roanoke Gas Co.'s existing distribution system. The city of Roanoke will receive natural gas for the first time when the line is completed. Cost of the construction is estimated at $596,800.

32. ASSOCIATED NATURAL GAS CO. has applied for an FPC okay on plans to build 14.5 miles of 8⅝-in. and 21 miles of 6⅝-in. distribution system in Sikeston and New Madrid, Mo., and surrounding rural area. The line would run from the Big Inch line in the vicinity of Oran, Mo. to Sikeston and thence to New Madrid. Approximate cost: $900,000.

33. ALGONQUIN GAS TRANSMISSION CO. has its application under FPC scrutiny for a 276-mile line from a connection with Texas Eastern's line at Lambertville, N. J., to Boston, with 492 miles of laterals and a compressor station in Middleton, Conn., included. Approximate cost of the proposed facilities: $27,549,000.

34. NORTHEASTERN GAS TRANSMISSION CO. will have its FPC hearing in Boston May 8, to investigate the company's proposed gas pipeline to Massachusetts, Connecticut, Rhode Island, Maine, Vermont, and New Hampshire, which would serve those states with gas purchased from Tennessee Gas Transmission and Transcontinental. In all, there would be 501 miles of 3- to 20-in. line built, in loops and laterals, in New England, costing $17.6 million.

35. SOUTHERN CALIFORNIA GAS CO. AND SOUTHERN COUNTIES GAS CO. have Midwestern Constructors Inc. at work on an 83-mile, 30-in. pipeline from near Palm Springs, Calif. to Puente, Calif. Completion date will be Oct. 1. Southern Counties completed an 18-mile, 20-in. line between La Goleta and Ventura, Calif. in January, and a 5-mile, 8⅝-in. line in the Malibu area in March.

36. CONSOLIDATED EDISON OF NEW YORK INC., BROOKLYN UNION GAS CO., KINGS COUNTY LIGHTING CO. are spending $12.7 million to build lines to receive gas from Transcontinental's Texas-New York line. ConEd will build 23 miles, Brooklyn will construct 12 miles, and Kings County will build 2.9 miles.

37. CENTRAL HUDSON GAS & ELECTRIC CORP. has Britton Contracting Co., Washington, Pa., on a 40-mile, 10¾-in. line from Tuxedo, N. Y. to Poughkeepsie. The line will carry Texas gas from the Home Gas Co. line to Highland on the west bank of the Hudson, and the contractor will run two 8-in. lines under the river to Poughkeepsie. Completion is scheduled for Aug. 1.

38. GEORGIA NATURAL GAS CO., a new company, has asked FPC permission for the construction of a natural gas pipeline of 8⅝-, 6⅝-, and 4½-in. diameter to run from Phenix City, Ala. about 335 miles to serve 25 towns in southern Georgia and Tallahassee, Fla. Cost of the line would be about $4.9 million. It has also applied to the FPC for an instruction to Southern Natural Gas Co. to sell gas to Georgia Natural at Phenix City, Ala.

39. EAST TENNESSEE NATURAL GAS CO. is building 400 miles of 16-in. and 12¾-in. line from Lobelville, Tenn. to the U. S. Atomic Energy plant at Oak Ridge, via Chattanooga and Knoxville. Two spreads (under Oman Construction Co. and N. A. Saigh Construction Co.) are near Knoxville and Athens, respectively. The job, including miscellaneous laterals, will be completed Oct. 1, and will cost $11 million. Still in the proposed stage is another East Tennessee line, which would be a mainline addition from a point near Rockford northeasterly to Kingsport and Bristol, Tenn., with laterals to six towns.

40. NIAGARA MOHAWK POWER CORP. will have William Austin Co., Pittsburgh, start work June 1 on 16 miles of 14-in. line from Therm City, south of Syracuse, N. Y. to Dewitt, east of Syracuse, and on 19 miles of 10¾-in. pipe from a point north of Liverpool, N. Y. to Fulton in Oswego county. United Engineers & Constructors Inc., Philadelphia, is supervising the job, which will be completed late this year.

41. SOUTHERN NATURAL GAS CO. has completed FPC hearings on the project that will increase its capacity to 529 MMcf if approved. Plans call for about 803 miles in main line additions, loops, and connecting lines in Texas, Louisiana, Mississippi, Alabama, Georgia, and South Carolina, and addition of 19,200 in compressor station hp. (Included in the above mileage figures is the 496-mile new high-pressure line proposed, which would extend from the Gwinville, Miss. gas field to Aiken, S. C.) The project would aid delivery of gas to Alabama, Mississippi, Georgia, and South Carolina.

42. MONTANA-DAKOTA UTILITIES CO. is presently engaged in building a 340-mile line from Worland, Wyo. to Cabin Creek, Mont. The project includes a compressor and dehydration plant at Worland. Line will cost 11 million and have a capacity of 20 MMcf daily.

43. UNITED FUEL GAS CO. is planning construction of 32 miles of 20-in. loop line on Central Kentucky Natural Gas Co.'s 14-in. line "E" northwest of Means, Ky.

44. COMMONWEALTH NATURAL GAS CORP. has received an FPC go-ahead on its proposal to construct a 200-mile natural gas pipeline from a connection in Greene county, Va. with Virginia Natural Gas Transmission Corp.'s line to Norfolk and Newport News. Virginia Gas will sell 55 MMcf to Commonwealth daily under the authorization. Commonwealth's construction will cost $6,425,000. Both Commonwealth and Virginia Gas were ordered to start construction by July 1.

45. NEVADA NATURAL GAS PIPE LINE CO. is planning to construct 122 miles of 10¾-in. line taking off from El Paso Natural's San Francisco line at Topock, Ariz., to Las Vegas, Nev., serving Needles, Calif., Boulder City, Henderson, and U. S. Gunnery School, all in Nevada, en route. Capacity, 6.5 MMcf.

South Jersey Gas Co. has asked FPC to grant authorization for 77 miles of gas pipeline it wants to build within the state, which would carry gas from the soon-to-be-completed Transcontinental line to various New Jersey cities and communities.

New Displacement Method for

MEASURING GAS FLOW

By J. C. WRIGHT

THE important thing in determining flow efficiency of pipelines is to know the Q or quantity of gas flowing through the pipeline under prevailing conditions. A new method, described in this article, has been developed whereby this flow can be determined economically, accurately, and quickly by displacement calculations.

In the past, many natural gas pipelines were constructed and put into operation without any cleaning except the conventional blowing, which at that time seemed ample for removing skids, rabbits, shovels, and other foreign objects. During this blow, a considerable amount of loose dirt, rust, and mill scale would be removed from the pipeline, but seldom was gas velocity sufficient to remove all of the loose substance—let alone the large amounts stuck to the interior wall of the pipe.

Solid welded construction of lines, using internal line-up apparatus, has greatly lessened the possibility of leaving large obstacles in the lines. Also, it is the general practice now to use internal cleaners on gas transmission lines following completion of construction and previous to placing the lines in operation. By doing this, the problem of maintaining high flow efficiency is made relatively easy.

The condition of the interior walls of a pipeline will vary even though the line was constructed of the same type and make of material throughout and constructed by the same contractor in a continuous operation. Some of the factors affecting the condition of the interior walls are topography and type of of soil in the area, as these influence the amount of dirt, dust and water which will get into the pipeline during construction; whether the pipe was stored a considerable time or put into the line immediately upon receipt of shipment; weather conditions existing during the construction period; and quality of construction.

On lines that were not properly cleaned previous to being placed in operation, the flow efficiency may vary to a great extent; therefore, before a cleaning program can be intelligently initiated, it is important that the flow efficiency of the pipeline in question be determined.

In the past the Q has been determined with fixed measuring stations where available, and with portable pitot tube installations where fixed facilities were not available. Check measuring stations on long gas transmission lines are normally spaced at long intervals and are therefore usually of small benefit in conducting flow tests. Portable pitot tube installations are expensive in that spe-

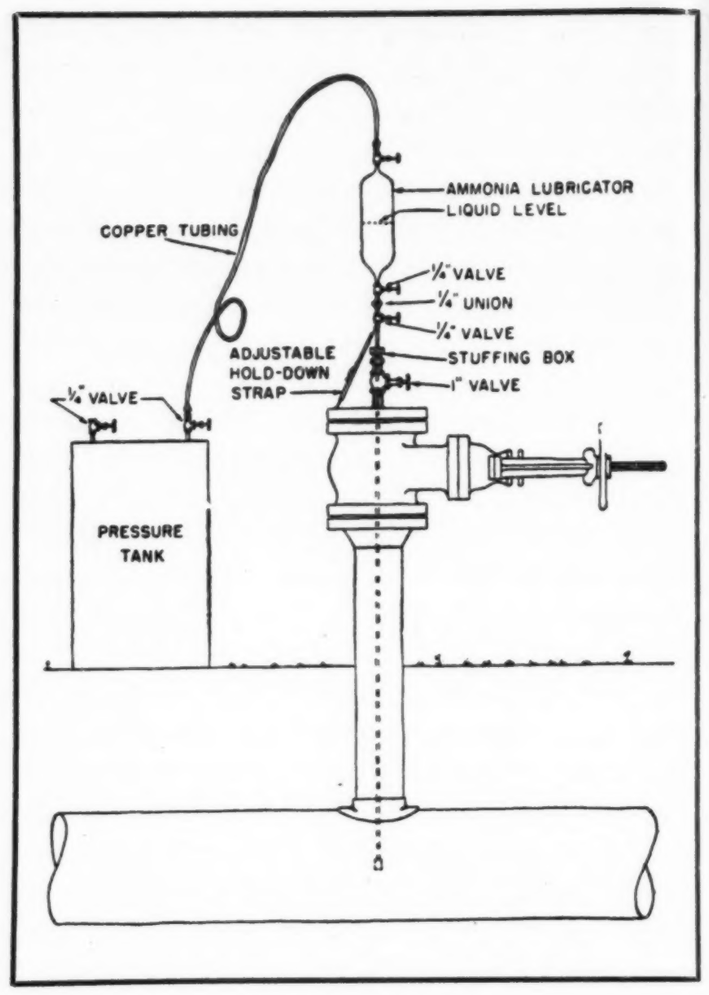


Fig. 2. Use of lubricator in empty-fill test.

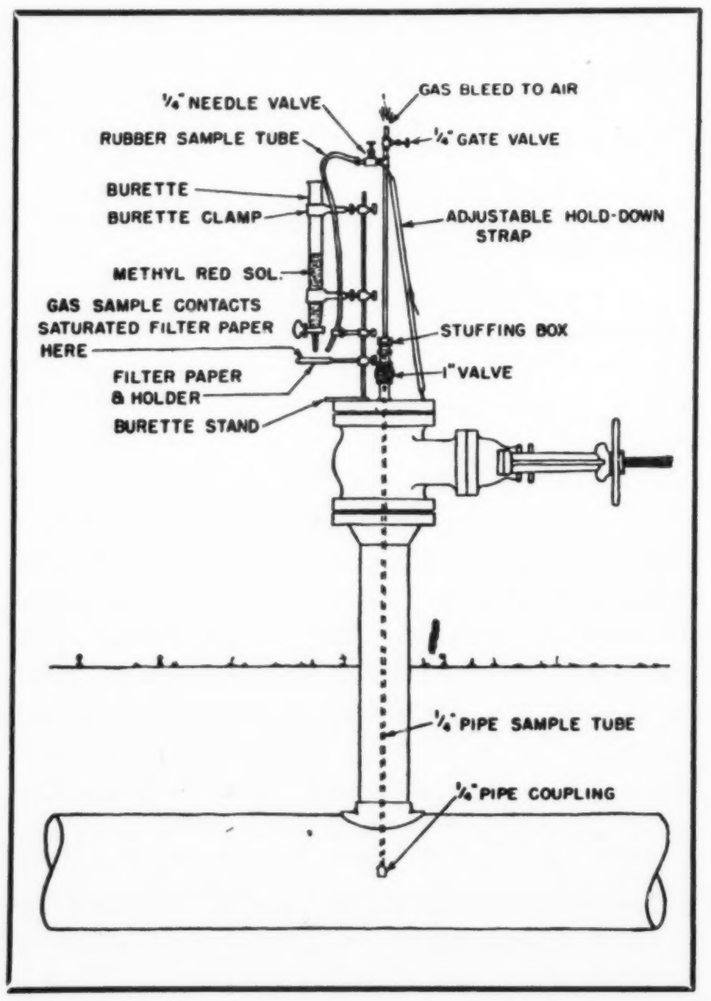


Fig. 3. Gas conducted in sample tube to saturated filter paper tells when test pipe has emptied.

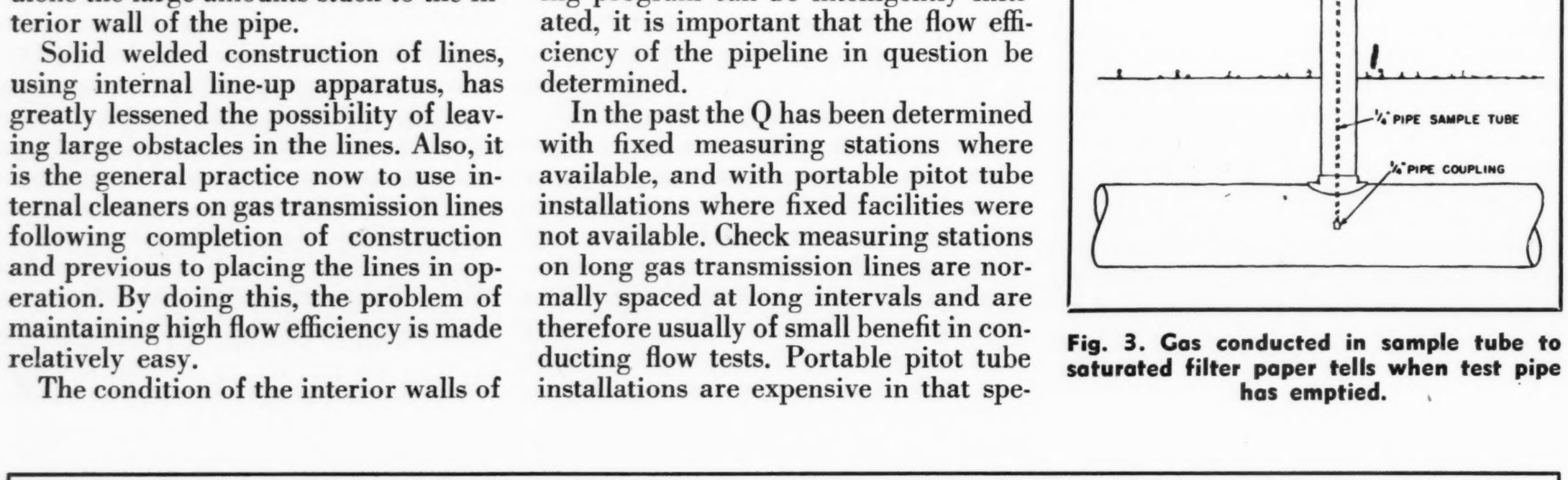

TAKE DEADWEIGHT GAUGE PRESSURE READINGS, GAS TEMPERATURES AND BAROMETRIC PRESSURES AT THESE POINTS
1
2
3
4
5
6
7
UP-STREAM COMPRESSOR STATION
AMMONIA INJECTED, DEADWEIGHT PRESSURES AND GAS TEMPERATURES TAKEN AT THIS POINT.
AMMONIA PICKED UP, DEADWEIGHT PRESSURES AND GAS TEMPERATURES TAKEN AT THIS POINT.
DOWN-STREAM COMPRESSOR STATION

Fig. 1. Typical setup for flow test from discharge side of upstream compressor station to intake side of downstream station.

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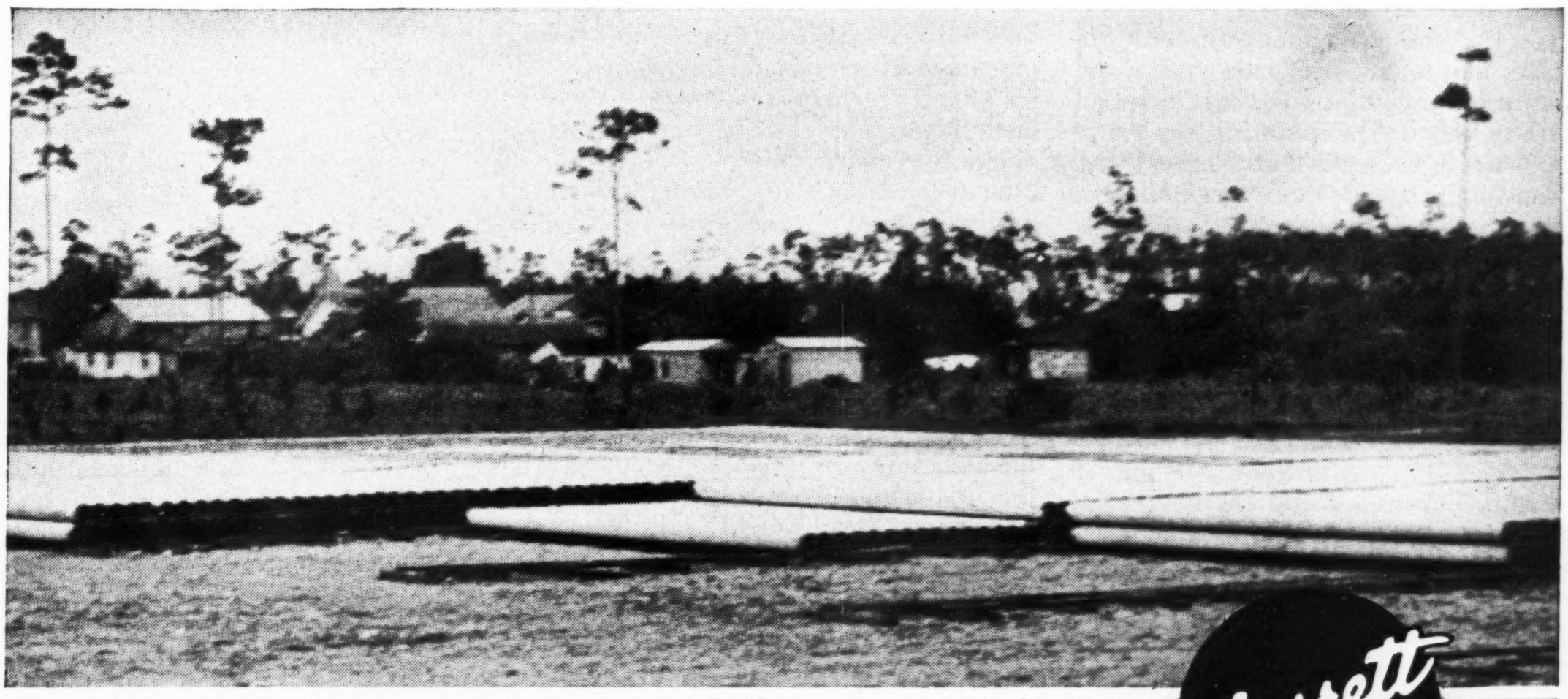

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cial taps must be installed at a location where the line has a straight run of pipe for a considerable distance.

A pitot tube previously calibrated by a fixed orifice measuring station has been found to be usually constant for the particular location where calibrated, but it can only be assumed that the same calibration factor is correct at any other location. Also, any change in the interior walls of the pipe at the pitot tube location will materially change the results of the gas measurement. This condition may occur from cleaning the section of line or be caused by a deposit of foreign matter on the pipe walls.

Where to Test

On long natural gas transmission lines, compressor stations are normally placed from 75 to 100 miles apart. For convenience and economy, it is a good practice to conduct a flow efficiency test from the discharge side of the upstream compressor station to the intake side of the downstream compressor station. (*Fig. 1* shows a typical setup for this test.) These two compressor stations should operate at constant pressures on the section of line being tested for a period sufficient to stabilize the flow and pressures previous to the time of testing, and continue to operate with constant pressures during the test. Should this test indicate a low overall flow efficiency, a test can then be made between each main line gate valve to determine if the entire line is low in efficiency or if the condition is confined to areas between certain valves. The setup for this test is the same as shown in *Fig. 1* except that deadweight gauges and thermometers are set up at each main line gate valve.

Tests conducted during the past year have fairly well proved that measurement of gas flow through pipelines can be calculated more accurately and economically by displacement than by portable pitot tube settings. The displacement method is conducted by calculating the volume in a known length of pipeline, upstream and downstream pressures, gas temperatures and barometric pressures are then taken. With these known quantities, the amount of gas in the section of pipeline can be accurately calculated:

$$Q = V \times \frac{Pm}{Pa} \times Tf \times Fpv$$

wherein

Q=Quantity of gas in test section
V=Volume of test section
Pm=Absolute Mean Pressure
Pa=Barometric pressure
Tf=Mean gas temperature factor
Fpv=Supercompressibility factor

Note: The supercompressibility factor was used in the test referred to in this article. The use of this factor is optional.

The next step is to arrive at the time it takes the test section of pipeline to empty and refill itself with a like quantity of gas. To do this, the following method is used. A quantity of ammonia is injected into the gas stream through the blow-off at the upstream end of the section of line. This is done by use of a lubricator (See *Fig. 2)*. By use of a sampling tube (See *Fig. 3)* located at the downstream end of the section of line, gas is taken from the center of the pipeline and conducted to a piece of filter paper which is kept saturated with methyl red solution. The moment ammonia is present, a discoloration of the filter paper occurs. At that instant, the original quantity of gas in the line has been emptied and if no changes in pressures have been made, the section has been refilled with a like quantity of gas.

J. C. Wright, assistant superintendent of pipelines, Panhandle Eastern Pipe Line Co., has served with Panhandle as welder, district foreman, division superintendent, and superintendent of gas control before commencing present duties in 1947. He has worked with Panhandle and predecessors since 1927.

Tabbing Results

A stop watch is started the moment the ammonia is injected and stopped at the first notice of discoloration of the filter paper. Dead weight pressures, gas temperatures and barometric pressures, which are relative values needed, are taken at the time the ammonia is injected and again at the time the ammonia arrives at the downstream end of the section of line. With the volume of the section of line known and the time it takes to empty and refill the section known, the quantity of gas flowing can be readily calculated. The 24-hr flow rate would be

$$Q = \frac{24}{T} \times V$$

where

T=Time between injection and detection points
V=Volume of gas between injection and detection points

Q=Actual volume passing in 24 hours

The first tests conducted by this method were made on sections of lines where check meters were located at the points where samples were taken, results on three different lines checking within one-half of one percent of the permanent measuring stations. The sections of line in each case were approximately 18 miles. During the first test, the elapsed time from the first discoloration of the filter paper until the last trace of ammonia-laden gas passed the sample tube was approximately five minutes. In making later tests, the amount of ammonia was reduced and the elapsed time for the slug of ammonia-laden gas to pass the sample tube was from 30 seconds to three minutes dependent upon the velocity of the flowing gas.

Typical Sample Report

The length of the slug is determined by the amount of time it takes the ammonia to vaporize and be absorbed into the gas stream. Actually, the length of the slug is of little importance since the time used in calculating the Q is that which elapses from the time the ammonia is injected until the first trace discolors the saturated filter paper. The following is a typical report of samples taken:

Location	*Time (all a.m.)*	*Ammonia Present*
Gate 205	11:15	None
" 205	11:16	None
" 205	11:17	None
" 205	11:17½	Trace*
" 205	11:18	Strong
" 205	11:18½	Strong
" 205	11:19	Weak
" 205	11:19½	None
" 205	11:20	None

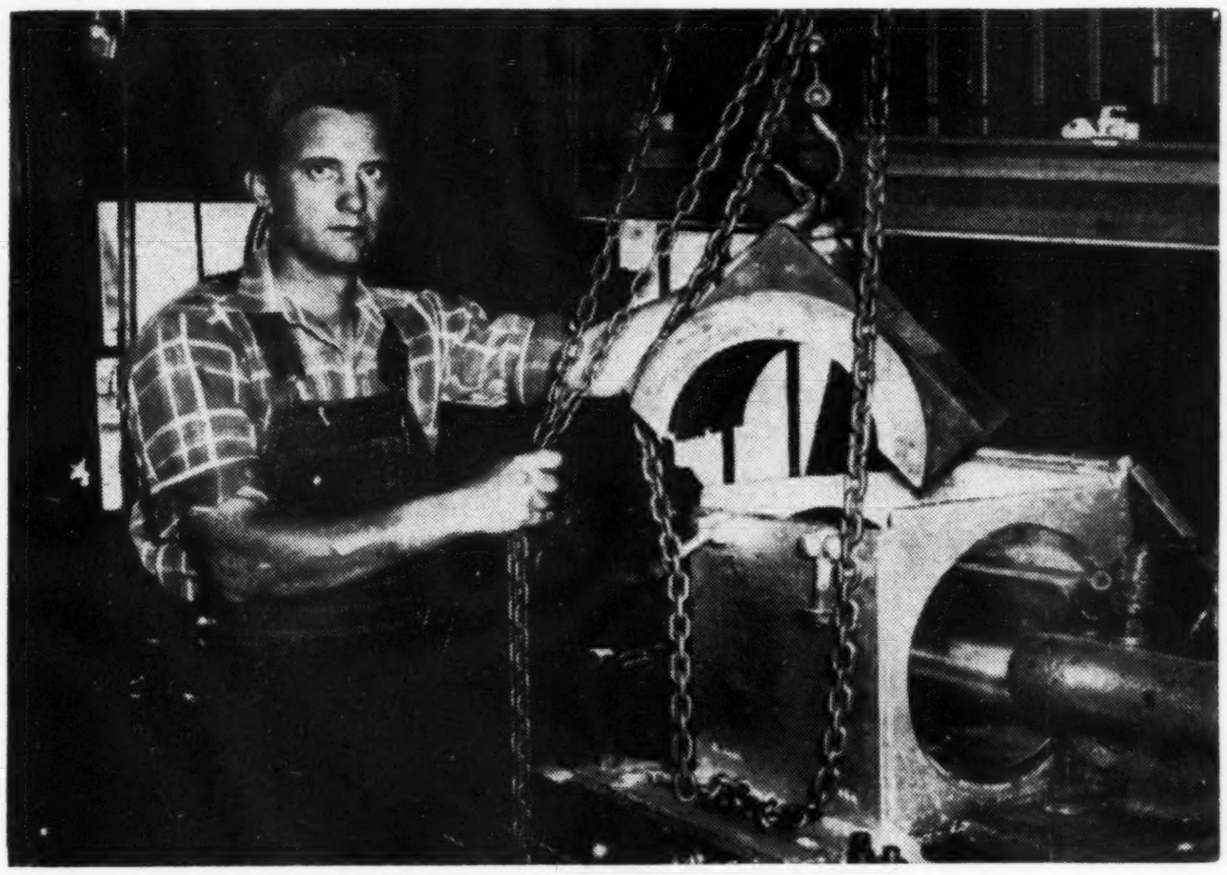
*(Stopped Watch)

Note: A second watch was used for time after first watch was stopped.

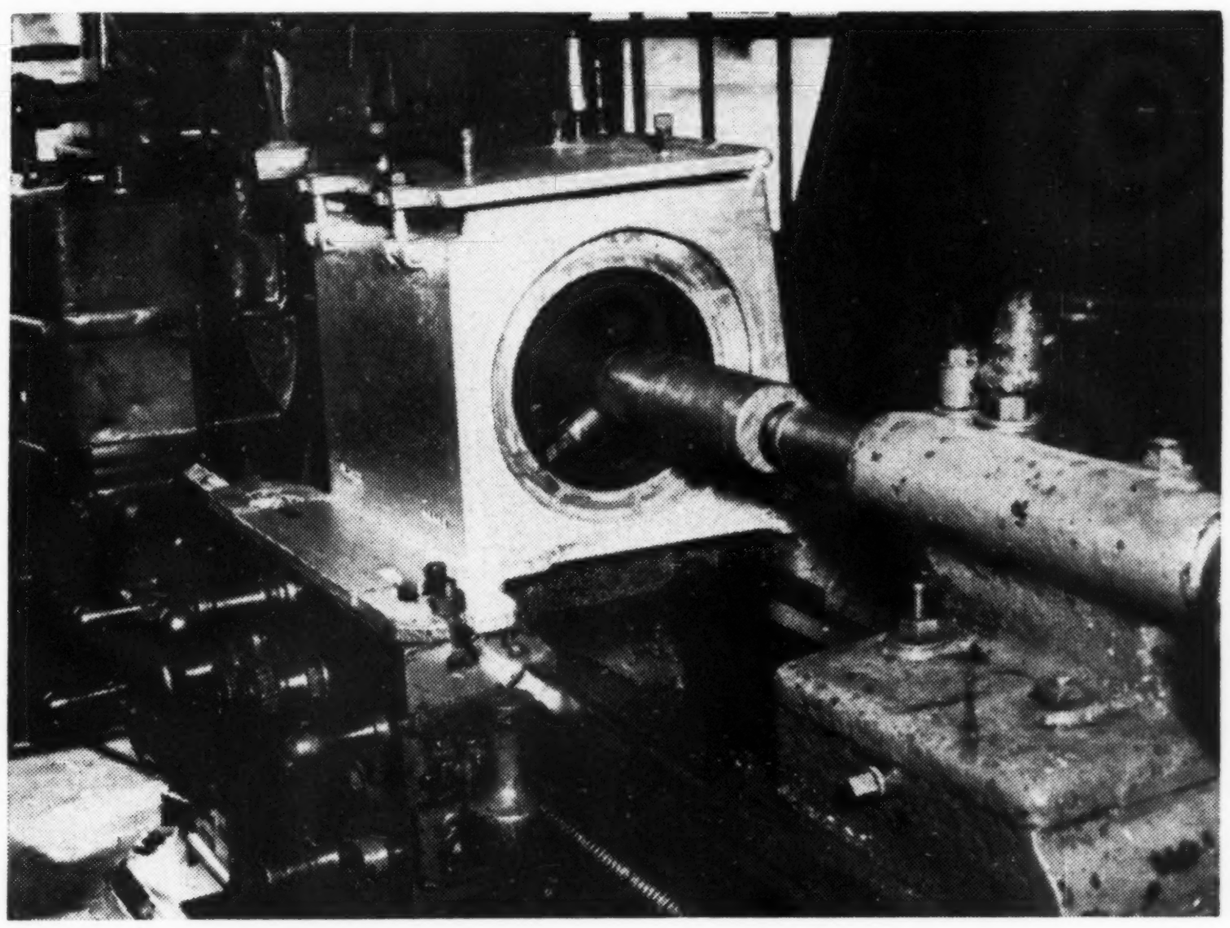
When the ammonia is injected, the pressure on the lubricator must be considerably greater than on the pipeline. This assures quick and complete injection of the ammonia. A quick opening valve is used to release the charge and a stop watch is started simultaneously with the opening of the valve. This watch can be moved ahead to the location of sampling tube or the exact time transferred ahead if adequate communications are available. In the tests referred to here, radio communication was used.

Stable Temperatures

In actual flow tests made with this method on over 1200 miles of line during the past year, it was found that best results are obtained when the ammonia is injected into the line at a location where gas temperatures are near stable. This is normally from 25 to 35 miles



BEARING MAY BE LOADED and removed from lathe with ease, using overhead chain hoist.



BEARING IS READY for removal in this picture, which shows the new jig mounted on lathe with boring bar and tool holder in right foreground.

Lone Star Installs Bearing Service

A complete bearing service for all type 75 and type 80 Cooper Bessemer compressor engines is now available at the Lone Star Gas Co. (Dallas) compressor department plant No. 3 at Ranger. The plant shop has a new holding fixture operating on a lathe, assuring speedy and accurate boring of main bearings for these engines. Work will be done for all gasoline and compressor plants on the Lone Star system.

The jig can be set up on a lathe and the bearing finished in approximately one and one-half hours, as compared to three or four hours for the same job without the jig.

The shop is also equipped with three additional jigs used for boring crank pin bearings and crosshead bearings for type 75 and 80 Cooper engines. The entire new equipment affords a complete bearing service on these engines for company plants.

This story originally appeared in the pages of *The Blue Blaze*, Lone Star Gas Co. employee publication.

downstream from a compressor station. However, this distance varies a great deal with ground temperatures and original temperature of the gas when it is discharged into the line at the upstream compressor station. The distance from the point the ammonia is injected to the location of the sample tube can vary, but 8 to 12 miles between these points seems best for normal operating and economical reasons. Multiple line river crossings, when located in the section carrying the ammonia, will normally cause an error in velocity calculations and a corresponding error in flow measurement.

Ammonia Diffusion

The ammonia is present in the gas stream near the outside walls of the pipe within a few seconds after it is detected in the center of the gas stream. There appears to be no noticeable molecular action due to the difference in weight of the molecules in the ammonia from those in the natural gas. The ¼-in. pipe injection and sampling tubes can be easily inserted into the line by hand. This was done on lines operating with pressures in excess of 800 lb.

These ¼-in. pipe tubes for injecting the ammonia should be of sufficient length that ammonia will be released directly into the gas stream and the sample tube should be set in such a position that samples are being taken at or near the center of the gas stream.

When to Sample

Velocity calculations made from an estimate of the flow rate will give the approximate time the ammonia will arrive at the sampling tube; therefore, it is not necessary to start sampling until just a few minutes before the ammonia is expected to arrive. When sampling starts, sufficient gas should be bled to the air so there will be no appreciable time lag from the time ammonia enters the sampling tube until it reaches the filter paper. The gas bled is controlled by a ¼-in. valve on top of the tube and a small flow is maintained through the rubber tube to the saturated filter paper regardless of the amount of gas bled to the air.

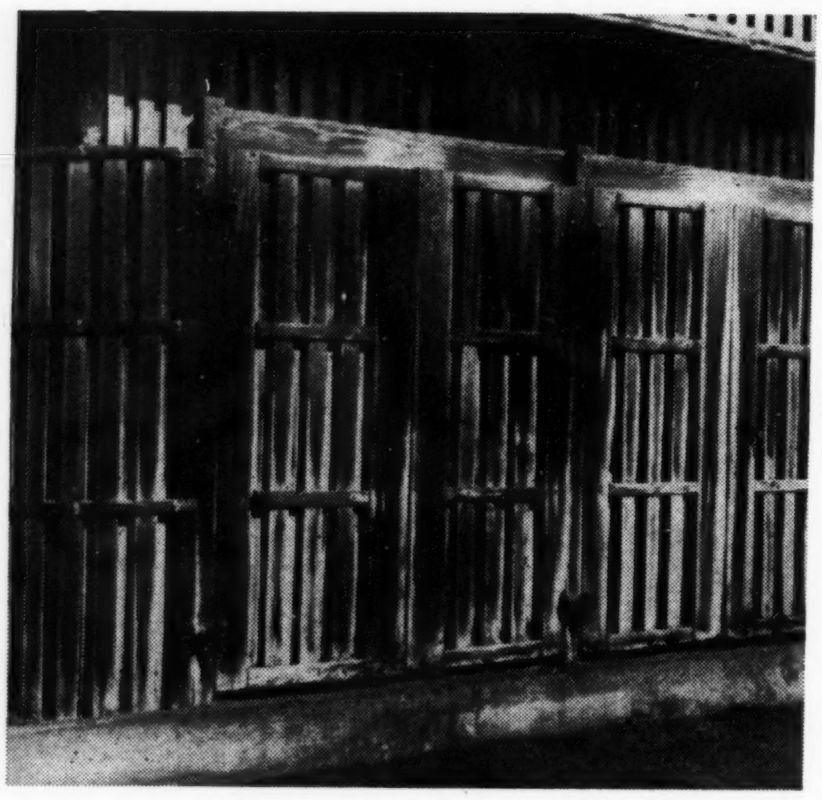
This method of measuring the quantity of gas flowing through a pipeline requires only a small investment in equipment. No expense is involved in putting taps on the line, provided the line is equipped with blow-offs. If blow-offs are not available, tests can be made by simply installing 1-in. taps at the locations where ammonia is to be injected and detected. Actual cost of material used in conducting a test is negligible and the number of employees required is held to a minimum.

Chemical Deterioration of Cooling Tower Lumber

By C. L. Blohm and H. D. Frazier

Exclusive

THE employment of cooling towers in the process industries for the dissipation of mass heat loads has been in general practice for many years, and this practice has been quite satisfactory from the standpoints of operation and economic considerations. However, such towers, when constructed of wood, are subject to certain types of deterioration, among which are chemical and bacterial attack, attack by other living organisms, such as the Teredo and similar wood-chewing insects, and fouling of the structure by algael growths. We herein will discuss chemical deterioration as involved in the failure known as "delignification."



DECOMPOSITION of wood is shown in photo at left (before delignification) and above (at an advanced stage of deterioration). Note fuzziness, discoloration of wood in picture above.

Very briefly, wood consists structurally of a series of hollow cells surrounded by the cell walls, adjacent cell walls having a common medial layer known as the middle lamella.[1] This common layer serves to cement the cells together and probably is largely responsible for the strength characteristics. The cell walls themselves consist of two generally distinct kinds of material, cellulose and lignin, and the cell cavity contains the so-called extraneous materials of wood consisting of sugars, salts, oils, resins, etc. These latter probably have little bearing on the subject under discussion. Rather extensive investigations into the composition of the cell wall and middle lamella indicate that the latter consists to a large extent of what is commonly classified as lignin.

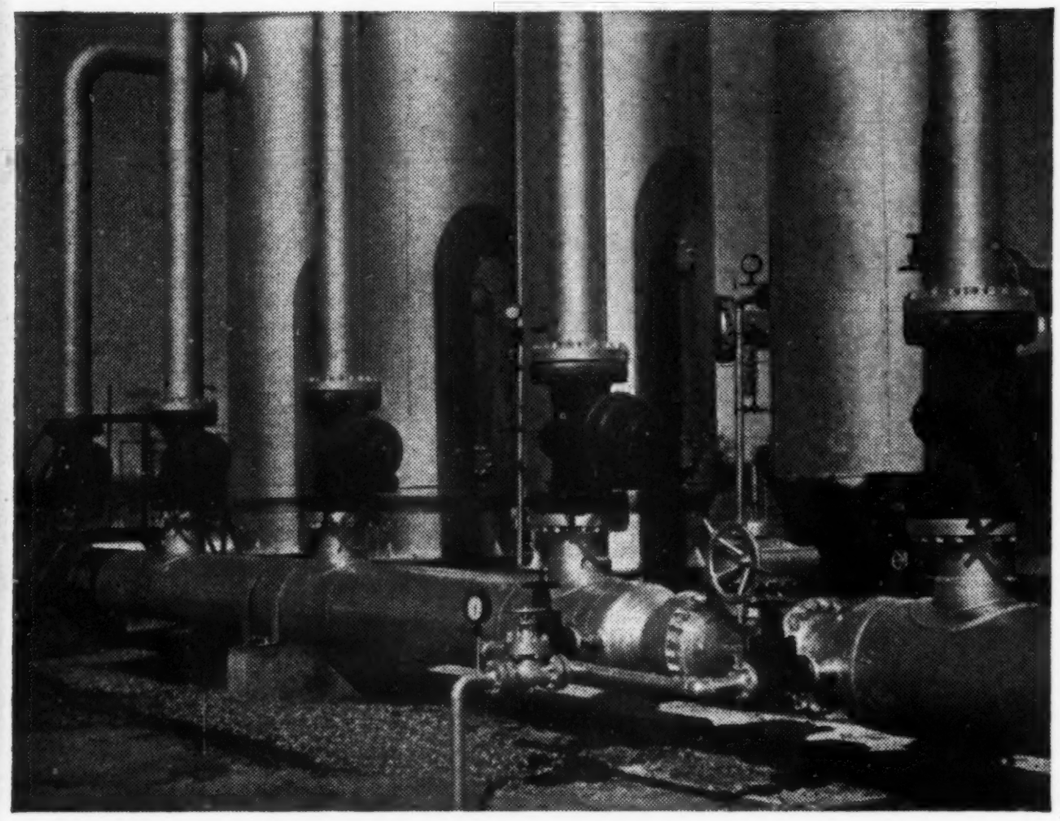
While the structure of lignin itself has never been thoroughly clarified, it is known to consist of certain general chemical groups and is classified analytically as the wood material soluble in strong caustic or bisulfite solutions as contrasted with the cellulose which is soluble in acid solutions. In wood chemistry the term "delignification" is meant to describe the removal of alkali or bisulfite soluble matter, and, since such material is that which is largely responsible for the strength of the wood, it is probably proper to apply this terminology to the structural failure of cooling tower lumber resulting from dissolution of lignin. However, the process as it operates in destroying a cooling tower is probably more complex than the simple procedure used in making wood analyses, since there are mechanical and other effects involved.

Delignification in cooling towers results finally in leaving the wood residue as a fibrous cellular structure of extremely low strength and in extreme cases this residue is probably largely cellulose. In one observed instance of cooling tower failure, large quantities of pure white short cellulose fibre were recovered from completely plugged pump and basin weir screens after severe and rapid delignification had occurred. In such advanced cases, the fact that the loose cellular structure will not hold nails or properly support other fastenings precludes almost any reasonable repair method short of complete replacement of the failed members.

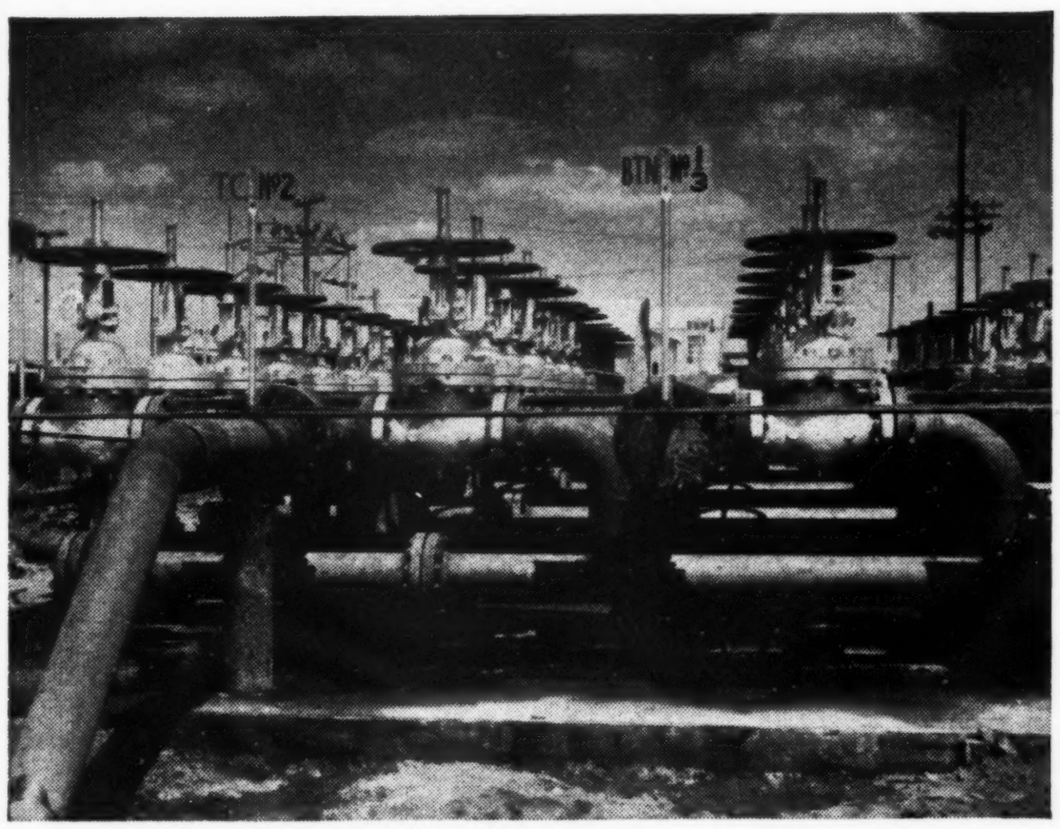
Thus, it may be seen that in installations where delignification can occur in a cooling tower, the resultant damage is of considerable concern to the tower owner, since expense is incurred not only in repair of the damage, but may in addition result from disruption of plant operation. The above introduction should not imply that the phenomenon of delignification occurs in all cooling towers, but the occurrence is of sufficient frequency to be of interest.

In the light of the above considerations, information of considerable value could be obtained from investigation of the causative factors involved in delign-

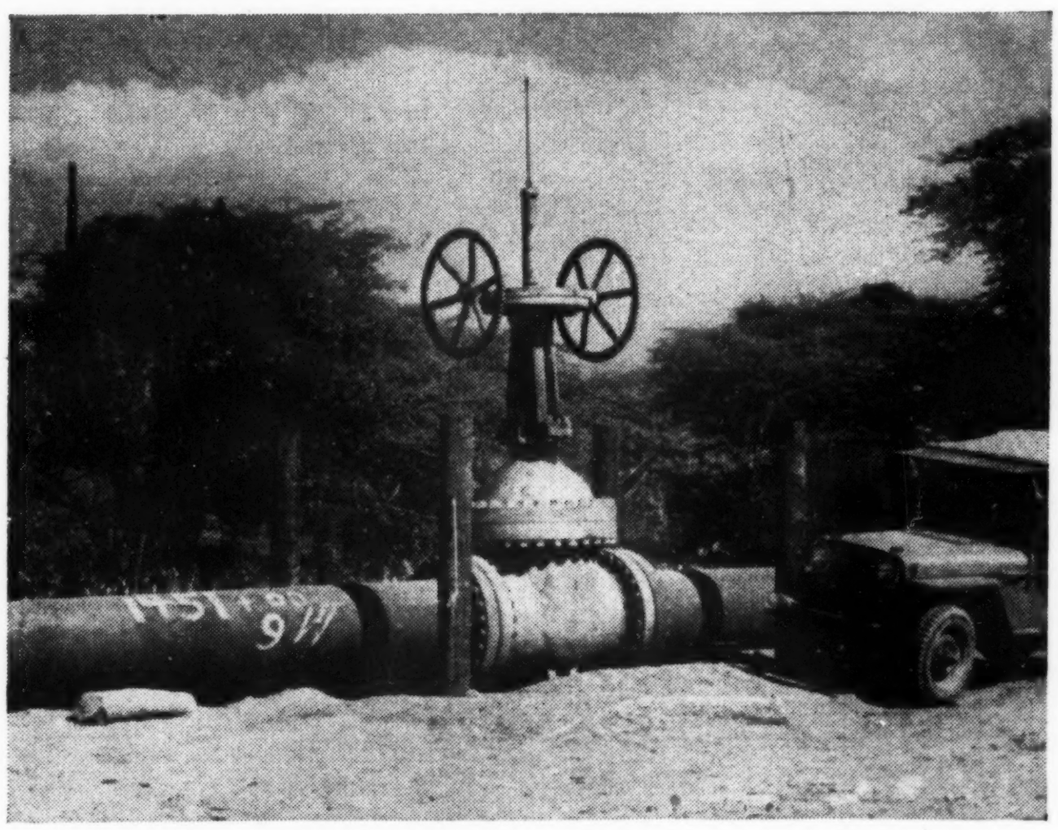
WALWORTH PIPE LINE VALVES...



Walworth 12-inch, steel, Lubricated Plug Valves on scrubbers in blower station yard of a southwestern pipe line company.



Walworth 8-inch, Series 600 Cast Steel, outside screw and yoke type, Pipe Line Gate Valves with stem protectors.



Walworth 26-inch, Series 600 Cast Steel, Pipe Line Valve with double handwheel operator in a South American pipe line.

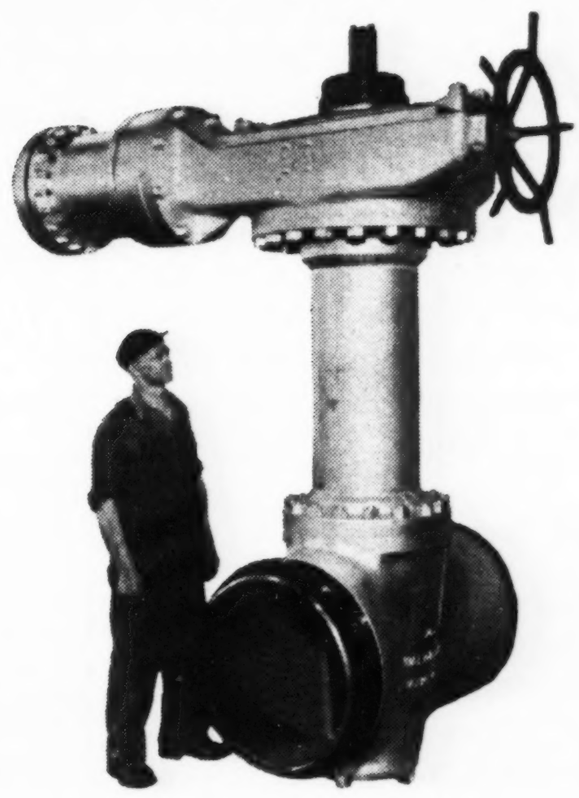
Walworth makes BOTH gate valves and lubricated plug valves for pipe line service

Walworth Pipe Line Valves are handling crude oil, fuel oil, gas, gasoline, and allied products in many of the most important pipe lines of the world. Their design is the result of years of experience in the production of valves to meet the particular requirements faced by the Oil and Gas Industry, in the distribution of its products through pipe lines.

Walworth Cast Steel Pipe Line Gate Valves and Cast Steel Horizontal Check Valves are accurately machined to close tolerances. They are produced for maximum cold working pressure, and have face-to-face and other dimensions in accordance with the current API standards. Discs of both Gate Valves and Check Valves open completely out of the passageway, allowing an unobstructed passage for scrapers or other tools.

Walworth Lubricated Plug Valves, because of the many advantages peculiar to the design of this type of valve, have gained wide acceptance in pipe line service, particularly on lines carrying natural or artificial gas and finished petroleum products.

Full information furnished upon request.



A Walworth 26 x 24-inch Lubricated Plug Valve for 960 pounds working pressure, with a high pressure cylinder for use in conjunction with automatic valve control. Built for natural gas pipe line service.

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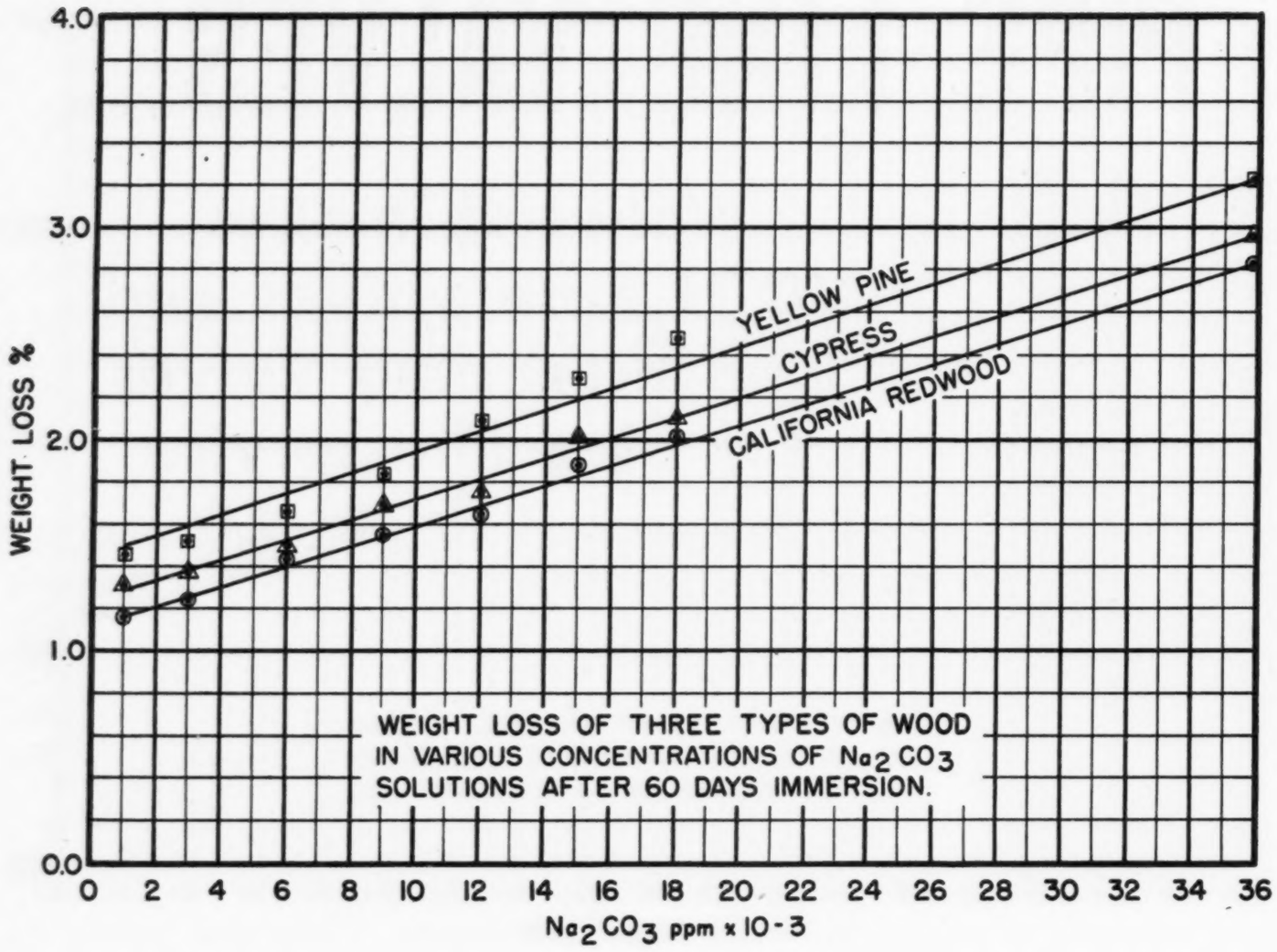


Fig. 1

ification and into means for inhibiting or completely preventing such occurrence. To this end a survey and laboratory investigation[2] were conducted in an attempt to evaluate some of the involved factors. The survey consisted of the examination of more than 500 cooling towers, covering an area of approximately 2 million square miles in the Pacific coast and mid-continent regions. While it was not possible in many cases to obtain sufficient long-time data to enable accurate conclusions to be drawn, complete reports were obtained in a total of 158 towers, and, in general, the remaining towers indicated the same basic factors as were evidenced in the 158 recorded reports. A survey of the data accumulated indicated the possibility that the presence of sodium carbonate in the water might be a principal factor in effecting delignification.

Three Wood Types

On the basis of the survey findings indicated above, the laboratory experiments were initiated to provide further evidence. These experiments were conducted on three types of wood commonly employed in cooling tower construction—California redwood, cypress, and yellow pine. Samples of each were prepared of approximately the same size and weight and these were dried in an oven at 95°C for 48 hours before final weighing. The specimens were then placed in the test solutions and allowed to steep for 60 days, after which they were removed and thoroughly washed in distilled water, the washings being returned to the original solutions.

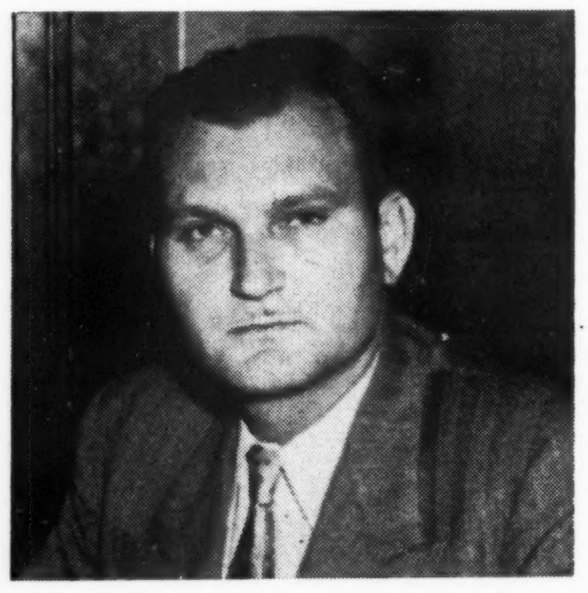
Finally, the samples were again dried at 95°C for 48 hrs and weighed, and the weight change was recorded as percent loss of the original weight. The test solutions were analyzed for total extract content and within the limits of error of the experiments the weights of the extracts equaled the loss in weight of the test specimens. *Table 1* and *Fig. 1* give the results obtained.

In order to test the presumption that sodium carbonate was a principal causative factor in delignification, the first eight test solutions used contained increasing amounts of this salt and no other. Since, in concentrations of 1000 ppm and greater, the pH of such solutions is essentially constant, this series of tests gives a direct correlation between weight loss and the effect of sodium carbonate concentrations independent of pH. Inspection of the tabulated data and the curves in *Fig. 1* indicates that the loss in weight is approximately linear with increasing sodium carbonate concentrations above 1000 ppm. Unfortunately, distilled water brought to the same pH, but with zero sodium carbonate content, was not utilized for a comparative base, and, therefore, one cannot predict the shape of the loss curve between the origin and 1000 ppm abscissa.

Little Salt Effect

Further inspection of the tabulated data indicates that high concentrations of neutral salts have little effect in promoting delignification as long as the pH of the solution is kept between 7.0 and 7.5. Under acid conditions there is some wood destruction which cannot be classified as delignification but becomes appreciable as the pH drops to 5.0 or lower. Finally inspection of the experimental data indicates that California redwood has somewhat greater resistance to delignification than the other woods employed.

While it is unlikely that one would ordinarily encounter salt concentrations in cooling waters as high as 36,000 ppm, it is possible to attain such con-



CLYDE L. BLOHM (above, left) was graduated from California Institute of Technology in 1930 and received his M.S. degree the following year at Cal Tech. He has been employed by several companies in California as chemist and chemical engineer, and joined Fluor Corp. in 1942. He is at present assistant director of research and development in that company. He is a member of the American Chemical Society and the National Assn. of Corrosion Engineers. HENRY D. FRAZIER (right) was graduated from the University of California in 1940. For three years following his graduation, he was associated with the gas division of Shell Development Co. (Emeryville, Calif.). Since 1944, he has been engaged in research on acid gas separation and dehydration processes for natural gas and gasoline as a member of Fluor Corp.'s research staff.

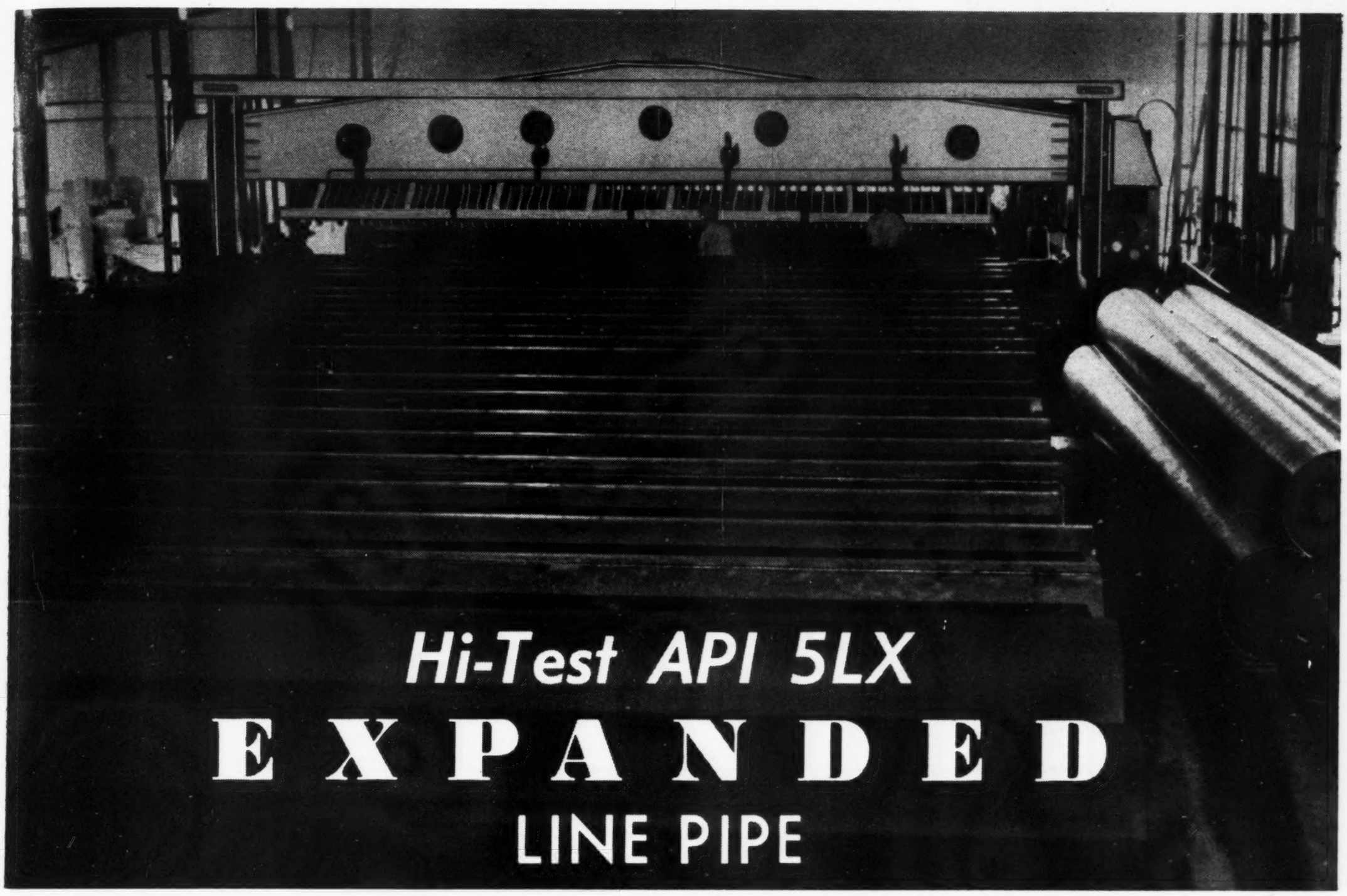


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TABLE I. COMPARISON OF COOLING TOWER WOODS

Sample	Solution	pH	% Loss in Weight REDWOOD	% Loss in Weight CYPRESS	% Loss in Weight YELLOW PINE
1	1000 ppm Na_2CO_3	10.94	1.16	1.32	1.46
2	3000 ppm Na_2CO_3	10.94	1.24	1.38	1.53
3	6000 ppm Na_2CO_3	10.95	1.46	1.52	1.66
4	9000 ppm Na_2CO_3	10.95	1.56	1.69	1.84
5	12000 ppm Na_2CO_3	10.95	1.64	1.76	2.09
6	15000 ppm Na_2CO_3	10.95	1.89	2.02	2.29
7	18000 ppm Na_2CO_3	10.95	2.02	2.11	2.48
8	36000 ppm Na_2CO_3	10.95	2.84	2.97	3.23
9	36000 ppm NaCl	7.49	0.21	0.22	0.42
10	36000 ppm Na_2SO_4 $CaSO_4$	7.51	0.18	0.17	0.39
11	36000 ppm $MgSO_4$ NaCl	7.2	0.15	0.16	0.39
12	36000 ppm $CaSO_4$ $MgSO_4$ HaCl	7.4	0.11	0.09	0.38
13	24000 ppm $CaSO_4$ plus $MgSO_4H_2SO_4$	5.01	1.22	1.20	1.99
14	H_2O plus H_2SO_4	4.50	1.48	1.53	2.06
15	24000 ppm mixed salts plus H_2SO_4	7.20	0.08	0.09	0.32

centrations in localized areas where salts have accumulated due to evaporation. Examination of the reported data on the inspected towers indicates that delignification is excessive in such localized areas and, in general, considerably greater than in the tower areas which are continuously washed by the circulating water. In the light of this observation, it is indicated that prevention of such salt accumulation by periodic washing of the affected areas would contribute considerably to prolonged tower life, and this would be true even in installations in which the circulating water itself is deleterious.

Complex Chemistry

Since the tests conducted with the sodium carbonate solutions were all at essentially the same pH, it is not possible to predict the effect of pH on the rate of delignification, although increasing pH could be used as a qualitative index of possible difficulty; however, the wood chemistry involved is somewhat complex. Although caustic solutions are commonly employed for effecting delignification of wood in preparation of paper pulp and other operations, these solutions are usually fairly concentrated. Redwood tanks have been employed in several instances for the storage of dilute caustic solutions in concentrations up to 3% for periods of several years without any noticeable deterioration.

The pH of such a solution would be between 13 and 14, so it is seen that pH alone is not a criterion of delignification. On the other hand, concentrated sodium carbonate solutions are not well handled in redwood tanks, and thus it is apparent that sodium carbonate seems to have a specific action in delignification processes, since the pH of even a concentrated sodium carbonate solution cannot exceed about 11.5. Nevertheless, in cooling tower operation, high pH in the water is nearly always due to accumulation of sodium carbonate, since free hydroxide is seldom encountered; therefore, it is possible to utilize the simple measurement of pH in the water as a qualitative indication of probable delignification resulting from carbonate accumulation.

Finally, there is undoubtedly a further contributing factor in the areas in which salt encrustation is allowed to occur; any liquid phase in contact with such encrusted salts is necessarily saturated and such saturated solutions will tend to soak into the wood to some extent. On subsequent drying of the area involved, the salts are left behind and may decrepitate due to loss of water of hydration, resulting in rupture of the cell membranes, or, on repeated rehydration, may swell, again causing cell rupture.

Either of these occurrences results in a type of exfoliation which gives the wood a rough, stringy appearance, and, furthermore, continually presents fresh surface for either repetition of the same occurrences or dissolution of more lignin by concentrated sodium carbonate solution. In any event, however, the attack appears to be considerably increased in the presence of sodium carbonate as contrasted with the mechanical action due only to the accumulation of neutral salts.

Of all the salts commonly occurring in cooling type towers, sodium carbonate is unusual in its ability to cause this type of mechanical destruction in that there are three different hydrate forms in addition to the anhydrous form, a complex of sodium carbonate and sodium bicarbonate and water, and, in addition, the possible conversion to sodium bicarbonate. This makes a total of six relatively common forms, all of which have different crystal structures and any one of which may be converted to any other by changes of temperature and available water.

Since the conclusions drawn above may indicate the harmful effects of sodium carbonate in cooling water towers, the most obvious recommendation would be the elimination of this salt from the system. Investigation has indicated that sodium carbonate itself has little effect in promoting delignification; however, bicarbonate ion is readily converted to this normal carbonate because of the increased temperature of the influent circulating water and its aeration. For this reason it is obvious that pH control is of extreme importance in carbonate hard waters, since the carbonate-to-bicarbonate ratio increases with increasing pH and at values of 9 or higher most of the hardness is in the form of normal carbonate. This means then that it is not necessary to remove the carbonate completely by means of ion exchange or other treatment, but it is necessary to maintain the carbonate in the bicarbonate form, a requirement that is satisfied by keeping the pH of the water between 7.0 and 7.5.

Control of pH

Sodium zeolite treatment of carbonate hard circulating waters may lead to rather high concentrations of sodium carbonate and if such a treating method is used it is imperative that proper pH control be maintained as otherwise sodium carbonate concentrations can easily become excessive.

Since it has been pointed out that the presence of neutral salts in the water does not contribute appreciably to delignification, other treating methods probably can be used with reasonable safety—provided again, however, that pH is properly controlled. Since treating of the water is employed primarily for the protection of mechanical equipment, it is unlikely in most cases that pH of less than 7.0 will be encountered, since acid waters in general are not suitable for use in contact with most structural metals. However, it is realized in some instances that inhibited waters of pH as low as 6 are sometimes used in circulat-

THREE STAGES *in deterioration of cooling tower wood are shown above. Intermediate stages (left and center) progress to final rotted condition shown at right.*

ing systems. This practice is probably reasonably safe although, in general, it would be well to keep the cooling tower water pH value greater than 6.5.

One rather special incident of apparent delignification is of some interest. In the operation of this particular tower some waste chlorine was injected into the tower water as a convenient means of disposal, since chlorination is commonly used in any event for algae control. However, the residual chlorine content of this water was allowed to go as high as 60 ppm and under these conditions destruction was quite rapid in the cooling tower decking, although the other conditions of the water—that is, pH and sodium carbonate content—were reasonably satisfactory. This observation would indicate that excessive chlorine concentrations should be avoided and that in general oxidizing materials should not be permitted to accumulate in any circulating water.

No Waste Disposal

In this connection, it might be well to point out that a cooling tower and its circulating water should never be used for disposal of waste materials, except in very special cases. In the event that such a practice must be resorted to, more than routine control should be maintained on such a tower in order to determine the effects of such contaminants. Since, in regions in which water is scarce, it is a sufficiently difficult job to maintain the cooling tower water in proper condition, such difficulties should not be aggravated by the addition of further contaminants.

As to the prevention of delignification, the following comments and recommendations may be made.

Unfortunately, in many instances a cooling tower is not given nearly as much care and attention as is commonly employed in the maintenance of mechanical equipment, and yet such a tower is an important part of a processing plant and represents a considerable capital investment. The most important means of prolonging tower life is proper control and maintenance, and such care should consist first of control of the water for sodium carbonate content and pH. These two factors are inter-dependent, however, to a considerable extent, since control of pH between 7.0 and 7.5 automatically limits the normal sodium carbonate content to a low value. Furthermore, as pointed out previously, delignification is nearly always greatest in non-operative sections of the cooling tower which are so located as to undergo alternate wetting and drying with consequent accumulation of salt encrustations.

Photographs show pictorially progression of typical delignification in these non-operative tower sections. Periodic hosing or other cleaning of aerators and structural members would serve in large part to eliminate this factor, and such treatment can be effected while the tower is in operation. In the event of cessation of tower operation as a result of general maintenance or repair-shutdowns, inspection of the tower should be made and all sections properly cleaned if necessary.

In a search for other preventive methods, some rather cursory field investigations were made on the use of protective materials. Preliminary results indicated that sections treated with materials which reduce the transfer of sodium carbonate containing water through the wood structure exhibited some increased resistance to delignification. However, the results of these studies were not too conclusive, and they have not been pursued further.

In some instances in the past, painting of non-functional members has been employed with some success, provided the painting is properly maintained, since most paints do not stand up too well under the conditions found in cooling tower operation, and thus have to be renewed at intervals. However, good aluminum paint seems to provide effective protection, requiring only occasional replacement. If painting is employed, some care must be taken to prevent the accumulation of salt encrustation on the painted areas, since such is quite destructive to these coatings. In a few instances, cooling tower lumber has been impregnated with oil or with other water repellents with some success; however, the practice has certain disadvantages, a specific one of which is to increase fire hazard considerably.

Finally, any such impregnation or coating procedure can only be applied to non-operative sections of the tower, since any attempt to impregnate the distribution decking itself results in such gross alteration of the active evaporative surfaces as to reduce the tower efficiency materially. Furthermore, the use of any water repelling agent will result in channeling of the water flow, an occurrence which directly defeats the purpose for which the tower was originally constructed, since a tower's prime function is to effect good water distribution and adequate air to water contact. Thus, it is seen that while certain means may be taken to prevent delignification of parts of the tower structure, protection of the operating sections can be attained only by suitable control of the circulating water.

Summary

In summary, delignification of cooling tower lumber is an active problem of considerable concern to many industries. Investigation has indicated that such delignification is due primarily to high concentrations of normal sodium carbonate in the circulating water and associated high pH. Water control and proper care of operating towers have been recommended as suitable means for preventing or diminishing deterioration of towers due to delignification. However, the whole problem has been very briefly studied or investigated and presents a fertile field for the prosecution of research and the development of a solution.

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Communications Facilities Along The Super Inch

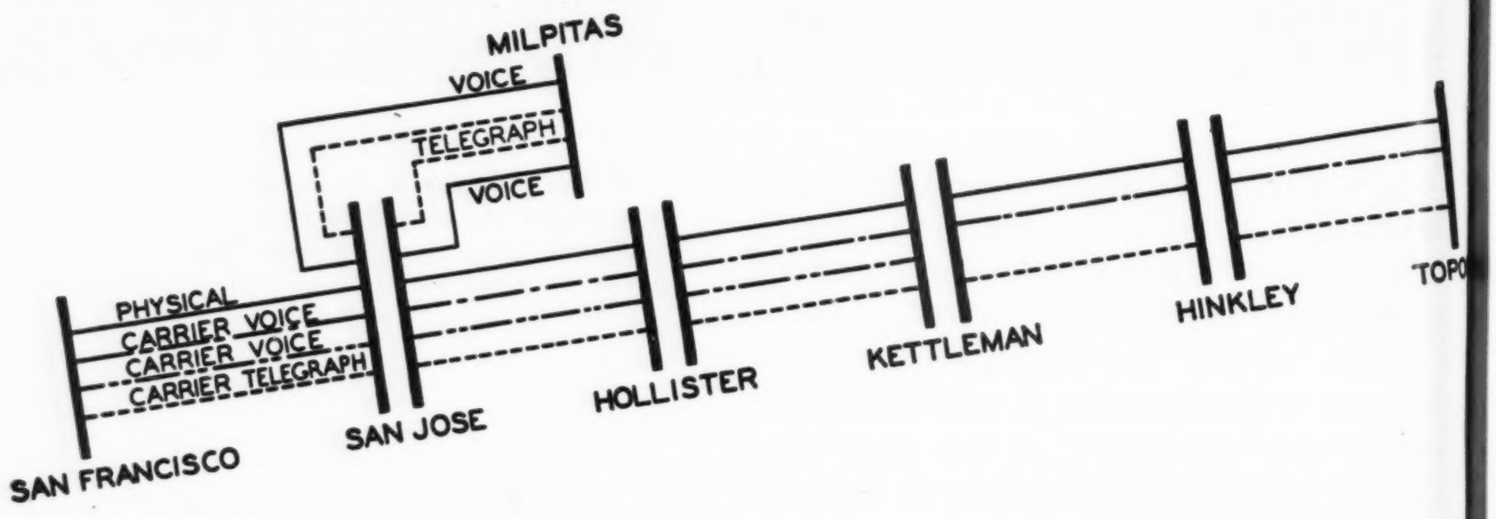

Fig. 2. Channel diagram for communications facilities for Topock-Milpitas gas line.

By L. L. CREIGHTON and R. H. MILLER

COMMUNICATIONS for gas line operations are no longer the simple matter of stringing a pair of wires in close proximity to the pipeline for the purpose of transmitting hourly readings and for maintenance needs. Illustrative of this is the operation of the 34-in. Topock-Milpitas gas line of the Pacific Gas & Electric Co., San Francisco, which will take gas transported from western Texas by the El Paso Natural Gas Co. and delivered to the terminal facilities of the Pacific Gas & Electric Co. at Topock on the California-Arizona border.

Exclusive

Compressor plants located on the California side of the Colorado river at Topock, near Barstow and at Kettleman, will be required to provide the necessary pressure to deliver the large volume of gas to the northern terminal of the line at Milpitas for ultimate use in the San Francisco Bay area.

Gas entering the lines from the gathering fields in western Texas will require approximately 44 hours before crossing the Colorado river into California. From the Topock terminal, just south of Needles, to the large storage holders in the Bay area will require another 22 hours. Due to the long time interval required to transport the gas, and the variations of consumption of gas with changes of weather, meteorology plays an important part in the problem of gas dispatching.

It is necessary that the gas control operators located in San Francisco know for many hours in advance what the weather conditions will be in the area served, so that sufficient reserve will be available in sections where peak demands are likely to be felt. Not only weather conditions, but the myriad changes along the line, including pressures, flow, and delivery to the line, must all be funneled into the gas control headquarters for correlation and interpretation into operating orders.

The communications necessary for over-all operation of the Topock-Milpitas gas transmission line will be provided by expansion of the company's private telephone communication facilities for providing telephone channels, and by the use of VHF radio, providing base stations at the compressor plants and mobile transmitter receiver units for patrol crews.

The telephone facilities will consist of, first, a rearrangement of existing wire facilities from San Francisco to Milpitas, approximately 50 miles, and from Milpitas to Kettleman, approximately 150 miles. Existing wire facilities now terminated at Milpitas will be extended by carrier to the company's telephone switchboard at San Jose. Telephone traffic primarily associated with the direct dispatching of gas will be handled by the regular PBX switchboard operators. In this way gas terminal operators will be freed from annoying interruptions and will be able to devote their time to handling calls primarily affecting operation of main gas transmission lines.

New wire facilities will be built from Kettleman for approximately 360 miles to the Topock plant on the Arizona border. The through communication channels will be provided by superimposing carrier current telephone channels on the wire line, and the physical circuit will be used by the main stations for maintenance and patrol crews and for local calls.

A teletype channel provided by a carrier telegraph circuit will be provided for the main gas dispatching channel, giving direct connection on a selective call or on an all-station-conference basis. The teletype circuit will be used for the transmission of readings, broadcasts of weather reports, and issuance of operating orders. By operating the teletype circuit on a carrier telegraph channel, simultaneous voice conversations can be handled on both the carrier telephone channels and on the physical wire circuit.

A through, carrier telephone channel will be provided from San Francisco to Topock, approximately 550 miles, with bridged way-stations at the main operating centers along the line. A second carrier telephone channel will be provided between San Francisco and the general superintendent's headquarters at Kettleman.

Fig. 1. Pressure limiting station No. 1, under construction. Pressures from these stations will be telemetered to compressor plants on both sides of the stations.

Mr. Miller is Engineer of Communications, Pacific Gas & Electric Co.; Mr. Creighton is on PG&E's communications department staff.

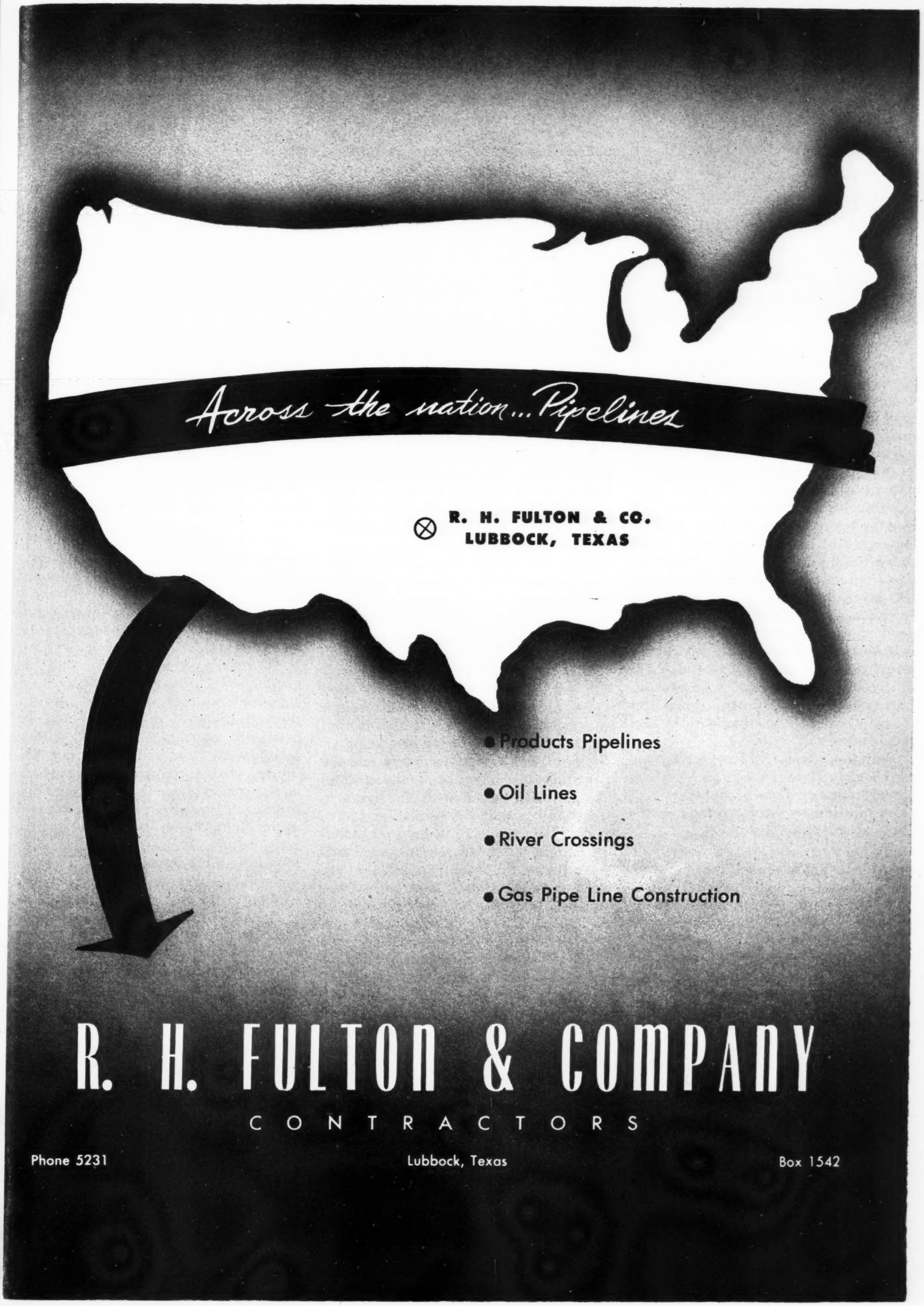
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Fig. 3. Radio telephone and control unit installation in trouble-car.

One of the unique features of the telephone carrier channels is that instead of using repeater stations the circuits will be made up of individual circuits operating in tandem. Terminals will be connected back to back through the telephone switchboards at major stations on a three-jack, four-wire bridging basis. This arrangement will give the operator at any of the stations the ability to monitor the through circuit without deteriorating the transmission level on the circuit. Provision will also be made so that any station may be called on a selective basis and the circuits can be sectionalized at the switchboards in the event of circuit trouble. Circuit flexibility is also enhanced by this arrangement, as any carrier section may be broken down and the calls switched to other wire or carrier facilities.

Main line valves will be spaced at approximately 10-mile intervals, and telephone stations will be provided at each valve location by means of taps on the physical telephone line.

Telephone Uses

In addition to the functions of providing voice and telegraph service, the telephone line will also be used for the remote control of throttling valves and for telemetering and alarm purposes. Due to the fact that the pipeline wall thickness is not the same in all sections of the line, it is necessary that the pressure be carefully controlled. Five pressure-limiting stations are to be located at strategic points along the line and pressures will be telemetered simultaneously to the compressor plants on either side of the limiting stations. *Fig. 1* shows the No. 1 pressure limiting station during construction. In addition, there will be metering at each of the compressor plants, and all of the information will be relayed to the Gas Control Office in San Francisco. *Fig. 2* shows a channel diagram of the communication facilities that have been discussed above. This diagram is necessarily very much simplified and does not show any of the filtering, repeaters, tapped way stations, or telemetering that will be provided—a detailed print of the complete layout would be unduly complicated and is beyond the scope of this paper.

Perhaps the most novel feature planned in the communication layout for this gas line is the installation of an automatic patrol of all main line valves. Each valve will be equipped with a mechanically operated, differential pressure device, designed to operate within certain pressure limits, and arranged to send out simultaneously (in both directions) a coded signal, repeated three times, indicating which valve shows an abnormal condition. This arrangement should materially reduce outage time and the time required for patrols. Due to the large number of such valve points and tapped telephone stations, a difficult filtering problem is encountered, in order that the carrier voice and telegraph channels will not be affected by the way station taps.

Way-Station Filters

It is proposed to use way-station filters having a voltage rating of 5000 volts, connected between the through line and each of the taps. With this high voltage rating, electrical protection of the filter will not be necessary and the possibility of shorted air gaps at these points will be eliminated. The arrangement will permit d-c operation of the coding devices mentioned above, as well as the physical voice circuits, and will have the effect of making the taps appear to be open circuits at carrier frequencies.

The line filtering as laid out will permit an ultimate of four carrier voice channels below a dividing point of 45 kilocycles. The fourth channel will be reserved for multi-channel telemetering requirements. Between Milpitas gas terminal and the Kettleman compressor plant, in addition to an ultimate of three carrier voice channels, the carrier telegraph and automatic patrol alarm, as many as 30 control, telemeter, and alarm functions will be required. Seven such channels are already in existence above 45 kilocycles, and the entire frequency spectrum from d-c up to 110 kilocycles will be in use. It is obvious that the filtering layout for such a system is very complex, and the utility of one pair of wires is approaching the ultimate practicable at the present development of the communications art.

In addition to the wire line communications which have been discussed above, and as mentioned earlier in this paper, VHF radio will be used by patrol and maintenance crews. This equipment is of the conventional frequency-modulated type operating in the 152-162 megacycle band. Some of the radio equipment is already in service, being used by the field forces during the construction period. Ranges of from 25 to 50 miles have been found to be consistent for this equipment, and will make possible rapid communication between repair and maintenance crews. *Fig. 3* shows a radio-equipped truck using the type of radio equipment now in service. Portable pack radio sets will also be used for communications between crews or patrolmen, at locations where access is available on foot only.

Patrol Radio Packs

Fig. 4 shows a patrolman equipped with a back pack radio. These sets have a range of approximately five miles and are carried like a knapsack, making it possible to maintain continuous communications from relatively inaccessible locations.

The construction schedules for the telephone facilities have been set up to coincide with that of the gas line, and those portions of the project that are primarily rearrangements of existing facilities are now well under way. The figures of time required for the gas to be transported from the gathering fields to the San Francisco Bay area, as given at the beginning of this article, and the large volume of gas to be handled, serve to point out the importance of adequate and reliable communications for the operation of the line.

It is felt that the communications facilities for operation of the line, as described above, will fulfill these requirements, and that the communications channels are actually the lifeline of the gas transmission service.

Fig. 4. Patrolman with portable radio pack set.

Michigan-Wisconsin's

AUTOMATIC DEHYDRATION PLANT

By Charles R. Hetherington

Exclusive

NATURAL gas, as it is received from producing fields or storage fields, generally is saturated or contains quantities of water in the form of vapor. The need for the removal of this water, or dehydration of the gas, early in any high pressure handling process is recognized in modern natural gas industry practice. Accordingly dehydration facilities assume an important role in natural gas installations. This article describes, by comparison with conventional design, an improved design solid-type dehydration plant to permit lower cost gas drying to sub-zero dew points for the larger daily volumes of gas being handled by the industry.

It is well recognized that moist gas at high pressure can form solid natural gas hydrates that plug pipelines as would ice, although these solid hydrates exist at temperatures as high as 65°F and higher at extremely high pressures. *Fig. 1*[1] gives the conditions under which gas hydrates can exist for methane and ethane and a series of typical natural gases. At present-day operating pressures of 500 to 1200 psi it is apparent that hydrates can exist in natural gas transmission and handling facilities generally during winter periods and all year in the higher pressure installations.

By removing the water from natural gas to the extent that no droplets of water condense under any operating conditions of temperature and pressure, the formation of natural gas hydrates with attendant operating difficulties can be eliminated. Gas regulator freeze-ups can be avoided, and troublesome and expensive heating of natural gas at city gate metering and regulating stations can be eliminated.

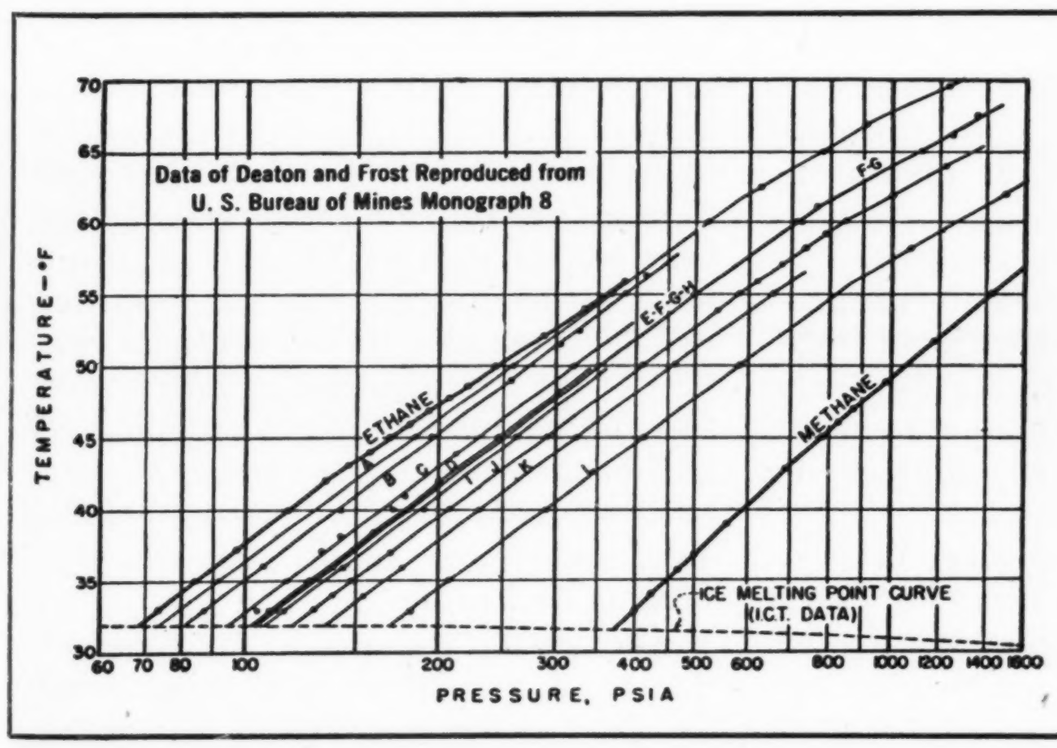
For the trouble-free operation of long-distance high pressure natural gas transmission lines, and of terminal regulator stations where the cut in pressure is large, it is often required that natural gas be dehydrated to a dew point at the operating pressure of —0°F. This requirement for low dew-point gas is particularly important when the gas is being transported into the northern states, where subsoil temperature at pipeline depth may reach 20° to 25°F during the early spring.

For sub-zero dew points, a dew-point depression in excess of 100°F is sometimes required, and to accomplish this depression, solid type dehydration plants are often used. This type plant employs a solid adsorbent material, generally an activated aluminum ore or activated silica which dries the gas upon contact. These desiccants will adsorb water to the extent of nominally 5% and 10% of dry weight, respectively, while maintaining a low dew point of treated gas. Upon reaching water concentrations of about this magnitude, these desiccants can be regenerated by heating and cooling in a cyclic operation to vaporize off the water and to cool to a temperature at which adsorption can again take place.

In the conventional design of a solid type dehydration plant, either two, four, six, or a larger even number of towers is employed. At any one time, half of the towers are on-stream drying gas while the other half of the towers are off-stream, being regenerated for the removal of water from the desiccant.

Fig. 2 is a schematic drawing of the conventional type plant. Tower A is shown on-stream drying gas, while Tower B is shown off-stream being regenerated. Wet gas enters the top of

Dr. Hetherington is senior engineer with Ford, Bacon & Davis, New York engineering consultants. He holds B.S. and M.S. degrees in chemical engineering from the University of Oklahoma and Sc.D. from M.I.T.



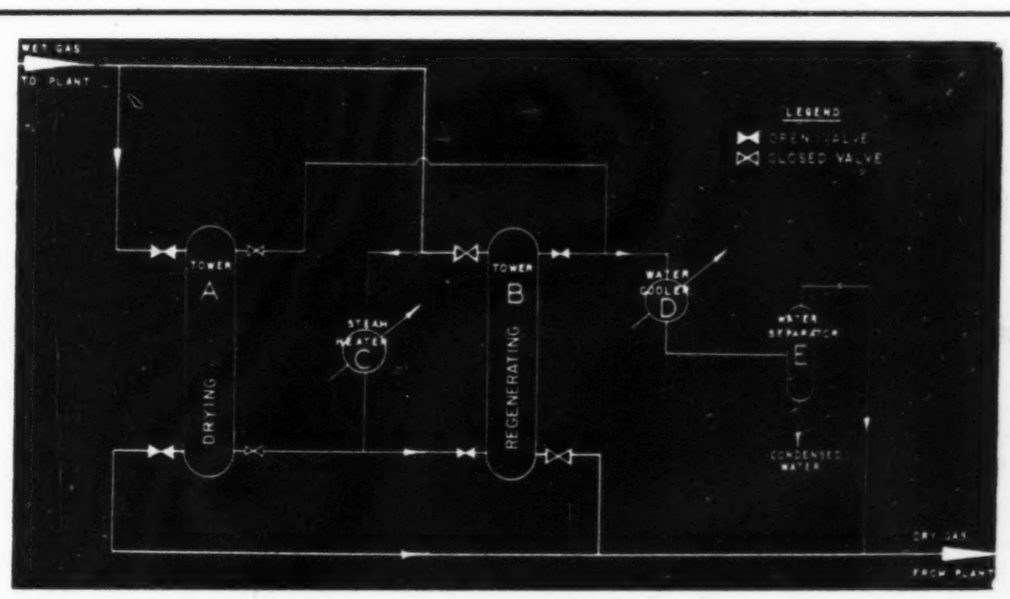


Fig. 1. (Left) Gas hydrate equilibrium curves for natural gas. Fig. 2. (Right) Flow sheet of conventional solid type dehydration plant.

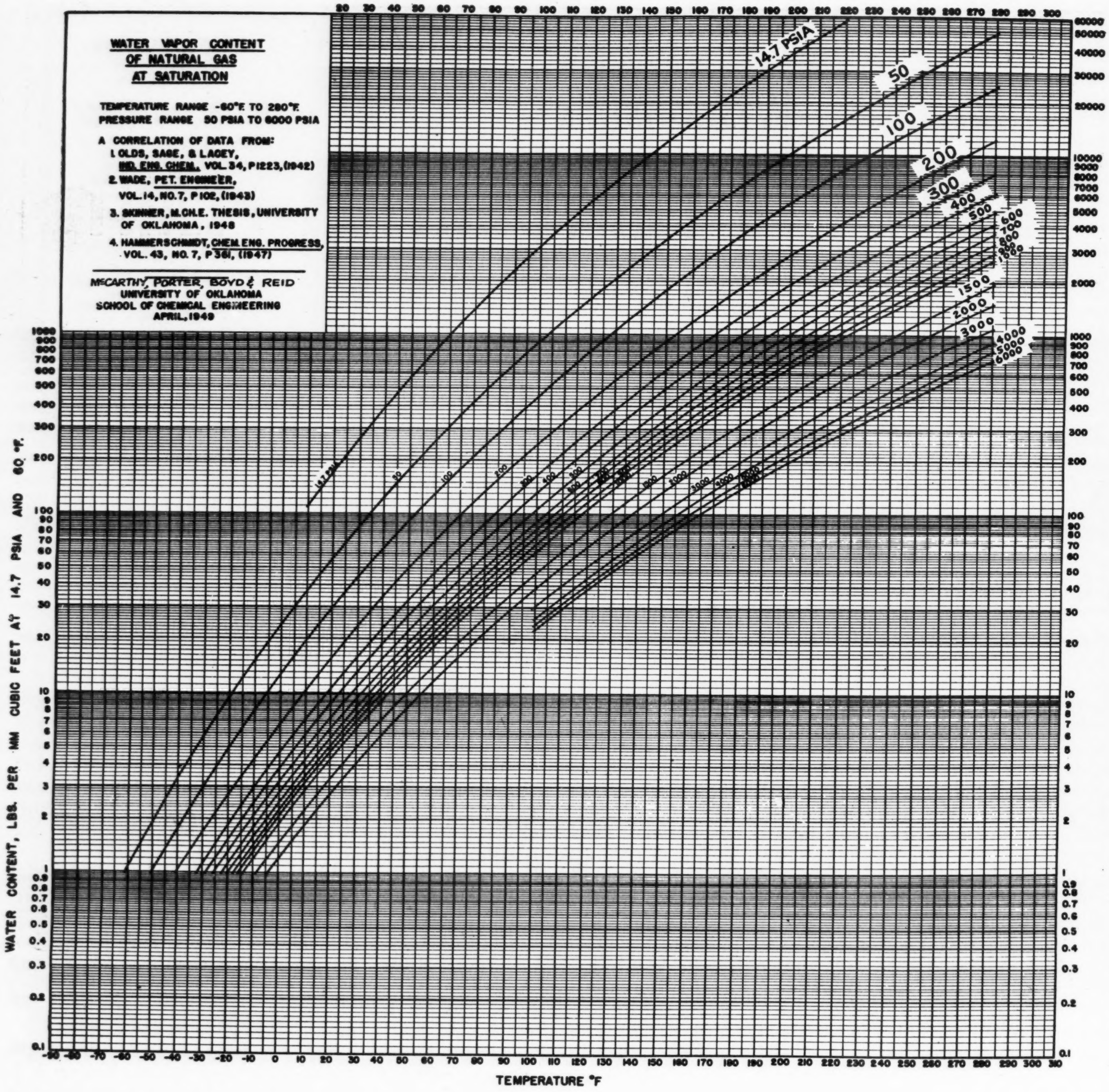


Fig. 2. Water vapor content of natural gas at saturation.

Tower A, flows down-flow through the bed of granular desiccant where it is dried, and out the bottom into the dry gas stream.

To regenerate Tower B and remove the water adsorbed during its on-stream period, a quantity of gas, approximately 10% of the main stream, is diverted through Heater C into the bottom of Tower B. This hot gas (at about 400°F) vaporizes the water from the bed of desiccant contained in Tower B and sweeps it to Cooler D where the water is condensed. This condensed water is removed as a liquid from Separator E and the uncondensed natural gas, which is saturated with water at condensor temperature, is mixed into the dry gas stream.

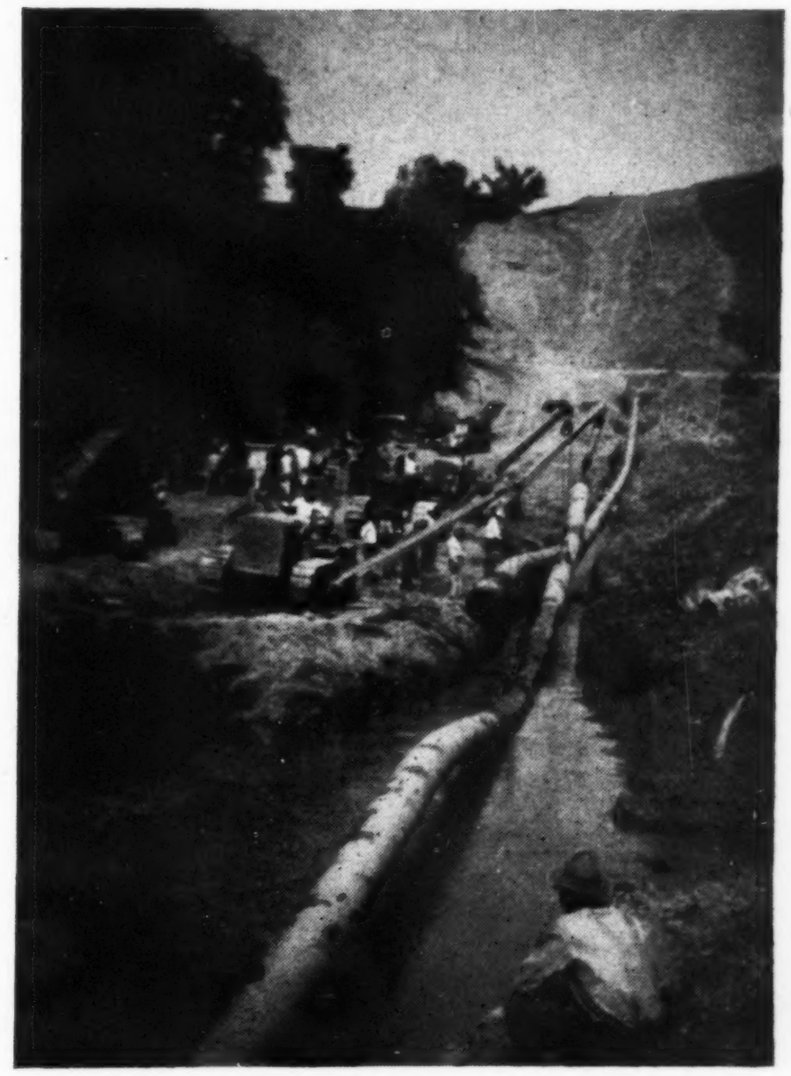
In some designs this natural gas which is used for regeneration is bled back into Tower A in order that it may be dried before mixing with the dry gas from the plant. Where a very low dew point is required, such operation is necessary inasmuch as the direct introduction of wet regeneration gas into the dry gas stream prevents the attainment of exceedingly low dew points in the dry gas stream.

When most of the water has been vaporized off of the desiccant in Tower B, heating is discontinued and a small stream of cool gas is passed through this tower to cool the bed of desiccant to a temperature of the order of 100°F, preparatory to returning it to drying service. In this type of design one-half to two-thirds of the regeneration time is spent heating, after which the source of heat is turned off and the last one-half to one-third of the regeneration time is spent cooling. Because the tower being regenerated heats for approximately one-half and then cools for one-half of the regeneration time, the heating and cooling equipment is idle one-half of the time and, accordingly, must be twice as large as if it were operated continuously to supply the required heating and cooling.

The heating and cooling to regenerate Tower B are timed such that when Tower A becomes saturated with water,

Above: Crossing Rocky swampland in State of Maine.

Right: Looping "Big and Little Inch" pipe lines with 26" line in Ohio.



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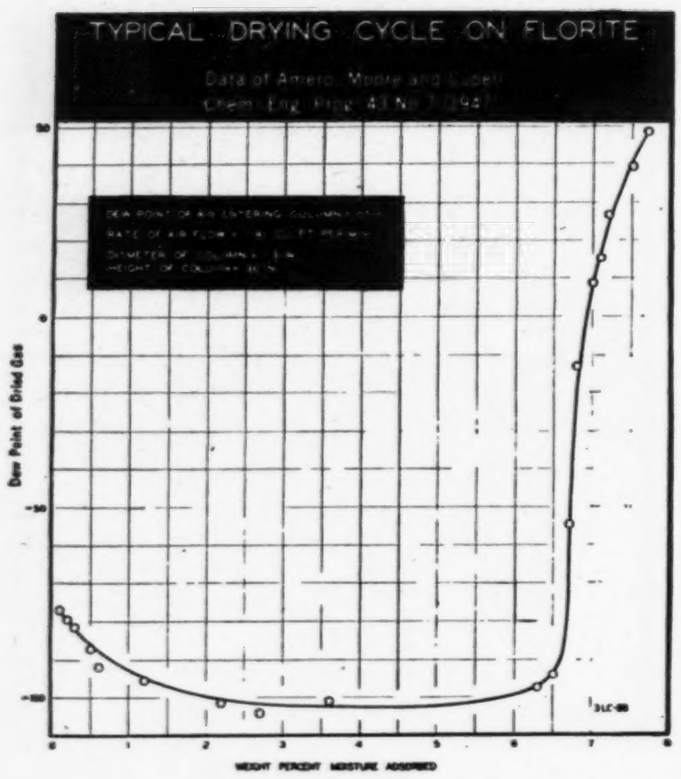


Fig. 4. Typical drying cycle on Florite.

Tower B may be put onstream to dry gas while Tower A is being regenerated. A cyclic operation is thus employed with half of the towers in a plant being on-stream to dry gas while the remaining half are off-stream being regenerated. Each of the towers in such a plant must be designed with a sufficient quantity of desiccant to remove the water contained in the quantity of gas that flows through the tower during each cycle. It is customary to design such plants with an 8-, 12-, or 24-hr cycle, since such periods permit ample time for heating and cooling and fit well into plant-operating shifts. In the case of large installations where 8-in. to 24-in. valves are employed with four to eight towers, the manual ability of the operator to switch the necessary number of valves limits the time cycle to not less than about 8 hours, or once a shift.

Fig. 3[2] shows the water vapor content of natural gas at various pressures and temperatures. Gas at 75°F and 500-lb pressure contains 50 lb of water per MMcf when saturated. If an 8-hr cycle is employed, the dehydration towers to treat 300 MMcf per day must contain sufficient desiccant to hold the amount of water contained in 100 MMcf of gas or 5000 lb of water. A conventional type plant designed for this job might employ eight towers, 5 to 6 ft in diameter, of which four towers would be in drying service and four towers in regeneration. The cost of a high-capacity plant designed on this basis is disproportionately large in the light of economies attained in the natural gas industry as a whole.

With the expansion of the natural gas industry, large quantities of gas are being handled daily from producing fields. In the producing fields in the mid-continent and Southwest, gas is received saturated with water at temperatures as high as 90°F, generally containing upwards of 50 lb of water per MMcf.

In addition, the gas industry is employing to a greater extent the depleted natural gas fields close to the market to store natural gas during the summer for winter time peak load use, and as gas is withdrawn from such fields, it generally contains water vapor in quantities again upwards of 50 lb per MMcf. A solid type dehydration plant designed along conventional lines to dry 300 or 400 MMcf per day, removing upwards of 50 lb of water per MMcf of gas, becomes enormous in size and correspondingly expensive in cost.

The need for an improved design to reduce size and cost has been recognized, the possibilities for improving the process have been analyzed and a new design has been developed.

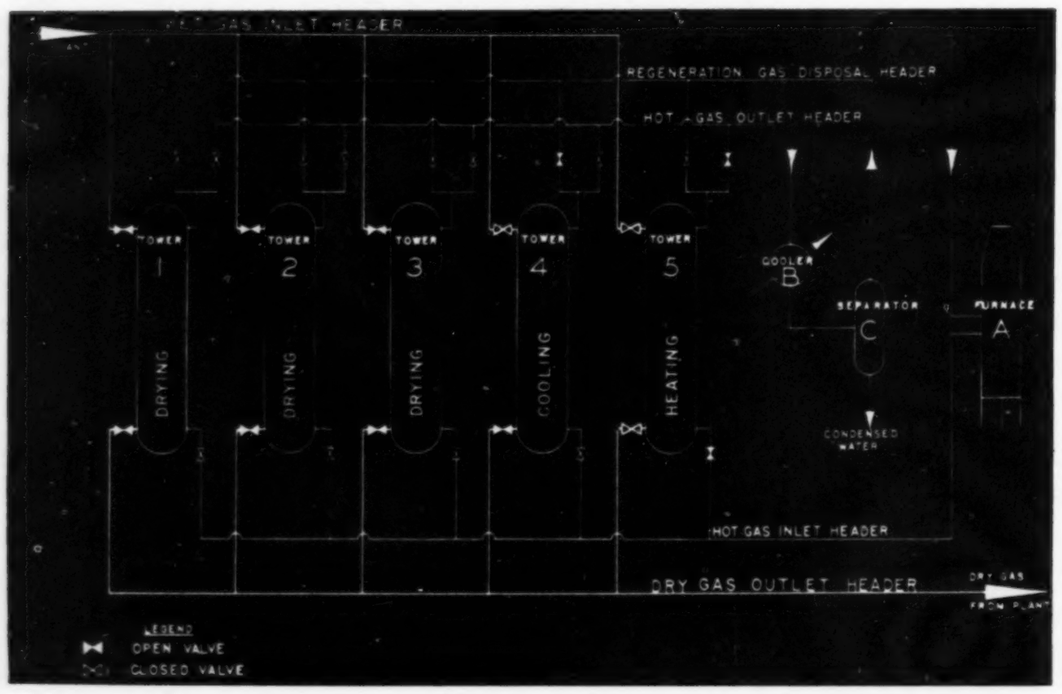
The most obvious step is to reduce the cycle length and correspondingly reduce the size of the adsorption towers, but this design change increases heating and cooling requirements for regeneration and poses a near physical impossibility if the valves are to be changed manually. In order to speed up the cycle without requiring increased heating and cooling facilities, a continuous regeneration system has been developed which permits the use of heating and cooling equipment 100% of the time instead of one-half of the time, thereby doubling the heat generation and cooling capacity of the conventional equipment within each operating cycle. This process for continuous regeneration also provides a scheme for reducing the number of towers required in a plant. Motor- or pneumatic-operated valves can be employed to eliminate the limitation of manual switching of the process valves.

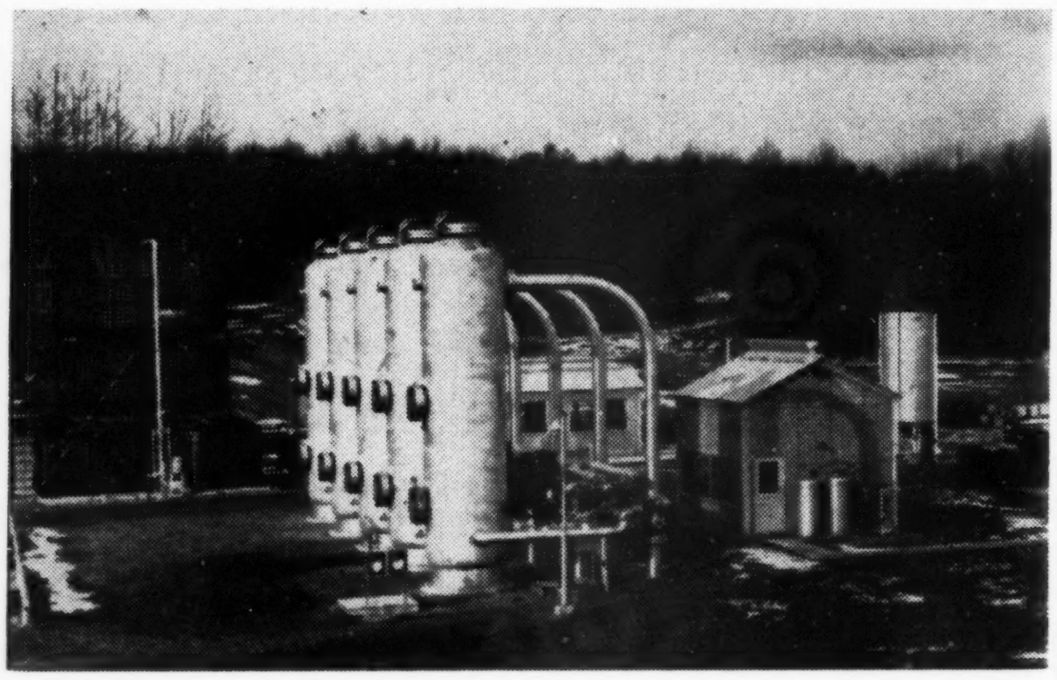
The Ford, Bacon & Davis process for natural gas dehydration employs a number of towers of which only two are ever out of drying service for regeneration purposes. Of the two towers regenerating, one is heated while the other is cooled. A short-cycle time is employed and valve switching is done in such a manner that both heating and cooling are done continuously. By speeding up the cycle the size of the towers can be reduced almost in direct proportion to the reduction in cycle time from that of the conventional process, and because heating and cooling are accomplished continuously, the heating and cooling equipment required to regenerate the smallers towers more frequently can be kept approximately the same size as in a conventional plant. The number of towers required in a multiple tower plant can be reduced inasmuch as only two (instead of half of the total number of towers in a plant) need be out of drying service for regeneration.

Electric motor-operated valves are employed for cycle switching with master control from an automatic electric timer to automatically handle the more frequent valve change operations required—without additional labor. With such controls, the dehydration plant can be made completely automatic, requiring only supervisory attendance by a part-time operator.

Towers in drying service are switched one at a time to regeneration as they become saturated with water. As a tower is removed from drying, a regenerated tower is placed in drying service. Thus in a multiple tower plant, each of the towers in drying service will have been in that service for a different length of

Fig. 5. (Left) Flow sheet of Ford, Bacon & Davis five-tower solid type dehydration plant. Fig. 6. (Right) Austin field dehydration plant.





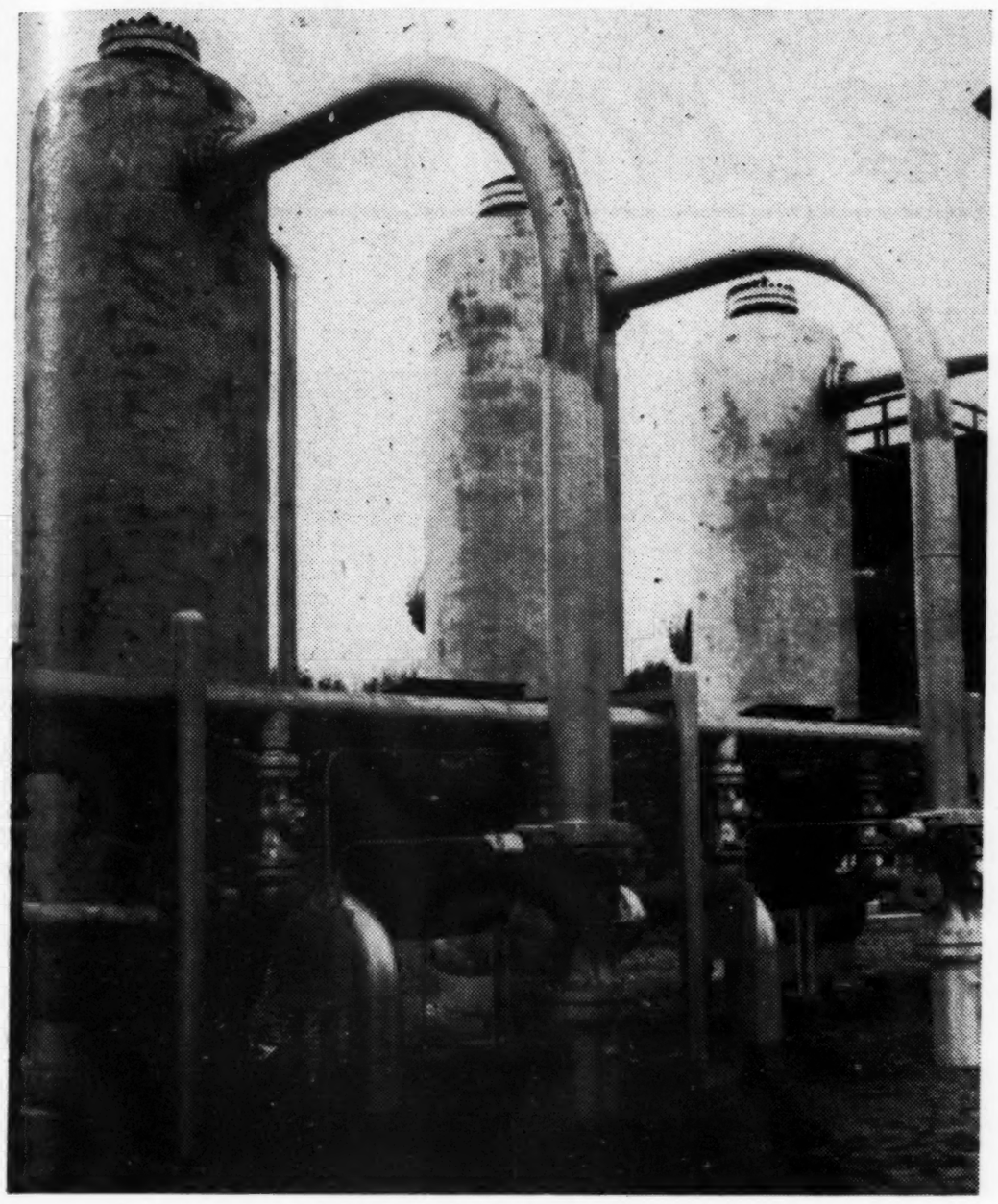


Fig. 7. Adsorption tower piping.

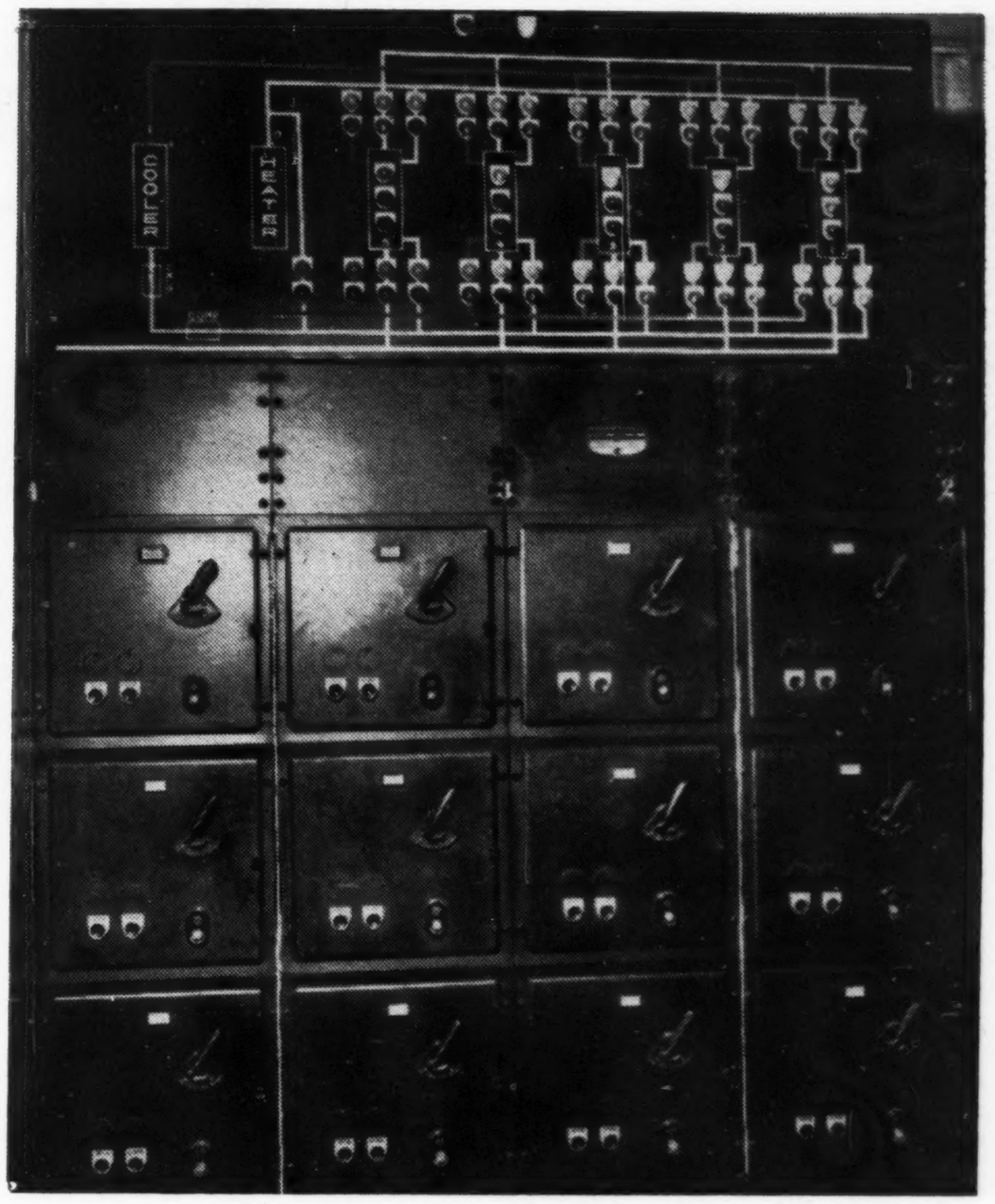


Fig. 8. Manual control panel and indicating light panel.

time and each tower will have adsorbed a different quantity of water. This type of operation is compatible with a constantly low dry-gas dew point only because of the characteristic of solid adsorbents, which yields almost constant dew-point gas for various quantities of water adsorbed in the desiccant up to a certain critical water content.

This characteristic is illustrated for Florite desiccant, an activated bauxite, by the data given in *Fig. 4.*[3] These data show that an essentially constant dew point is obtained until the desiccant reaches a critical water content. Above this water content the dew point of the dried gas rises sharply. The Ford, Bacon & Davis design takes advantage of this characteristic of solid desiccants by operating below the critical moisture content to switch towers from drying service one at a time, more nearly approaching continuous operation while still maintaining low dry gas dew point.

Fig. 5 is a simplified flow sheet of the Ford, Bacon & Davis design solid type dehydration plant employing five towers. Towers 1, 2, and 3 are in drying service, Tower 4 is being cooled preparatory to being placed in drying service, and Tower 5 is being heated for removal of moisture.

Wet gas to the plant flows down-flow through Towers 1, 2, and 3 in parallel and into the dry-gas outlet header. Heating and cooling operations are performed in a series with a small drag stream (about 5%) of wet gas taken off of the wet gas inlet header. This regeneration gas is heated in Furnace A to about 400°F, and flows into the bottom of Tower 5 (the tower being heated) where it vaporizes water from the desiccant contained in that tower. Hot wet gas effluent from this tower flows to Cooler B and Separator C where the water is condensed out and withdrawn.

Tower 4 has completed a heating cycle and is being cooled. Uncondensed regeneration gas from Separator C flows into the top of Tower 4 and out the bottom into the dry gas outlet heater to accomplish this cooling. The upper portion of the desiccant in such a tower being cooled cools off rapidly and serves to remove the water from the regeneration gas before it enters the dry gas outlet header to be mixed with the dry gas product from the plant.

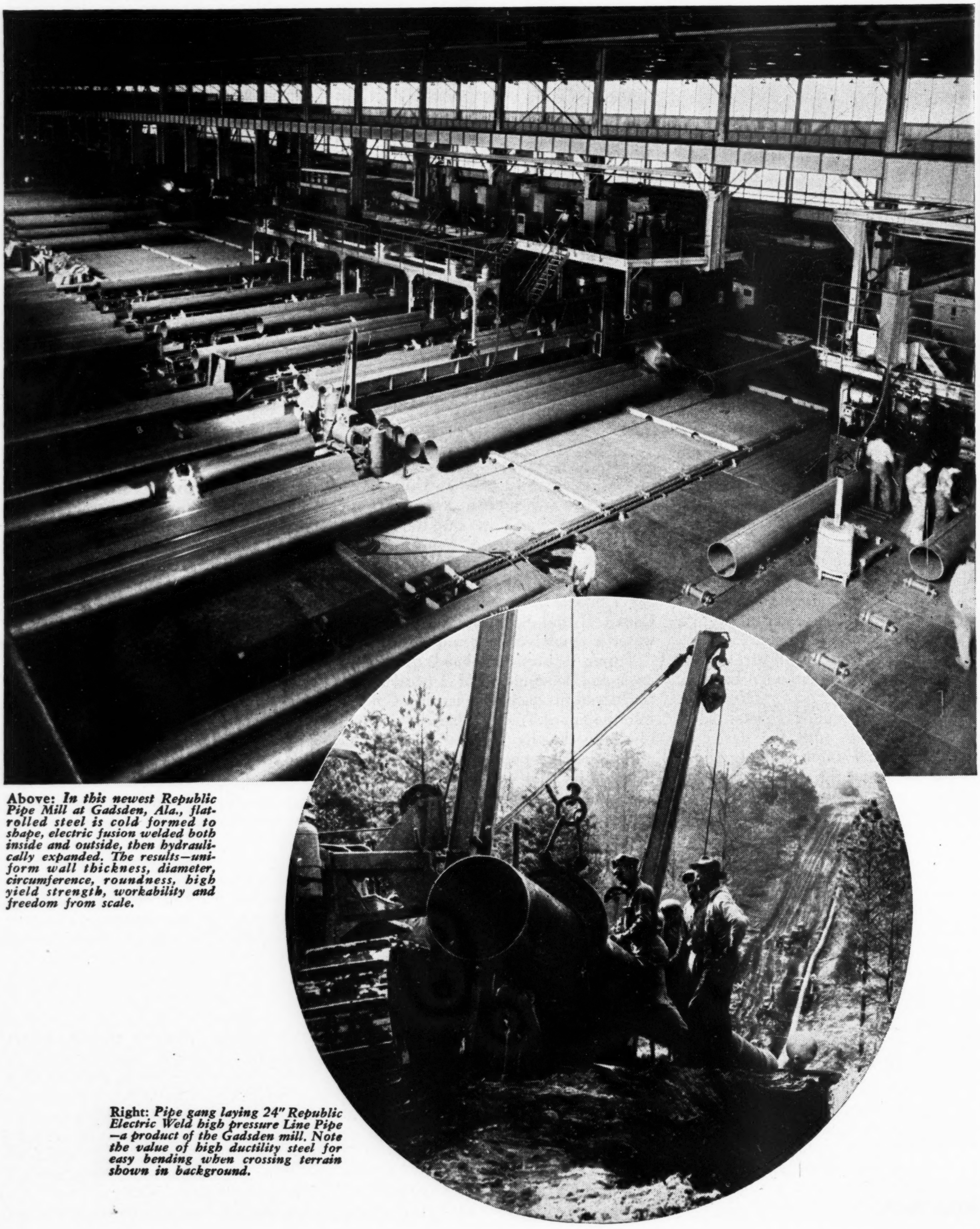
A direct-fired radiant furnace is employed to furnish the high-temperature heat required. The direct-fired furnace more economically replaces the conventional high pressure steam heater or indirect Dowtherm system. Drying, heating, and cooling operations are performed at the same pressure and the plant produces a constant, low dew-point dry gas product. The principal item of plant cost is that of the towers and their installation. By this improved process the size of tower can be reduced about in proportion to the decrease in cycle length and the number of towers in a multiple tower plant can be reduced by one-half of the number of towers less two. The costsaving from a fewer number of smaller towers more than offsets the increased cost of motor-operated valving and higher fuel consumption of this type of design.

Motor-operating mechanisms for valves with control equipment cost, installed, about $1000 each or $25,000 for a five-tower plant. The elimination of one 5½-ft diameter, 30-ft high, 1000-psi tower approximately balances this cost. A reduction in the size of the required towers to approximately one-half indicates the net cost advantage of this design. An economic balance of annual costs indicates that cycle lengths can economically be reduced to the order of one hour. Use of one-hour cycle lengths would represent additional initial cost advantage over the conservatively indicated figures above.

The first plant constructed from this new design was the Austin gas storage field plant of Michigan Consolidated Gas Co. in central Michigan. This plant was designed to dehydrate an average of 180 MMcf per day at an average pressure of 450 psi to a dew point below 0°F at operating pressures, and comprises five towers, 5½ ft in diameter by 22 ft high, with appurtenant regeneration and control equipment. Each tower contains 16,700 lbs of 4-8 mesh Florite desiccant retained in two grating screens. The towers are designed for maximum working pressure of 650 psi in accordance with the API-ASME code.

Austin field is employed to store gas

Going a Long Way



Above: *In this newest Republic Pipe Mill at Gadsden, Ala., flat-rolled steel is cold formed to shape, electric fusion welded both inside and outside, then hydraulically expanded. The results—uniform wall thickness, diameter, circumference, roundness, high yield strength, workability and freedom from scale.*

Right: *Pipe gang laying 24" Republic Electric Weld high pressure Line Pipe —a product of the Gadsden mill. Note the value of high ductility steel for easy bending when crossing terrain shown in background.*

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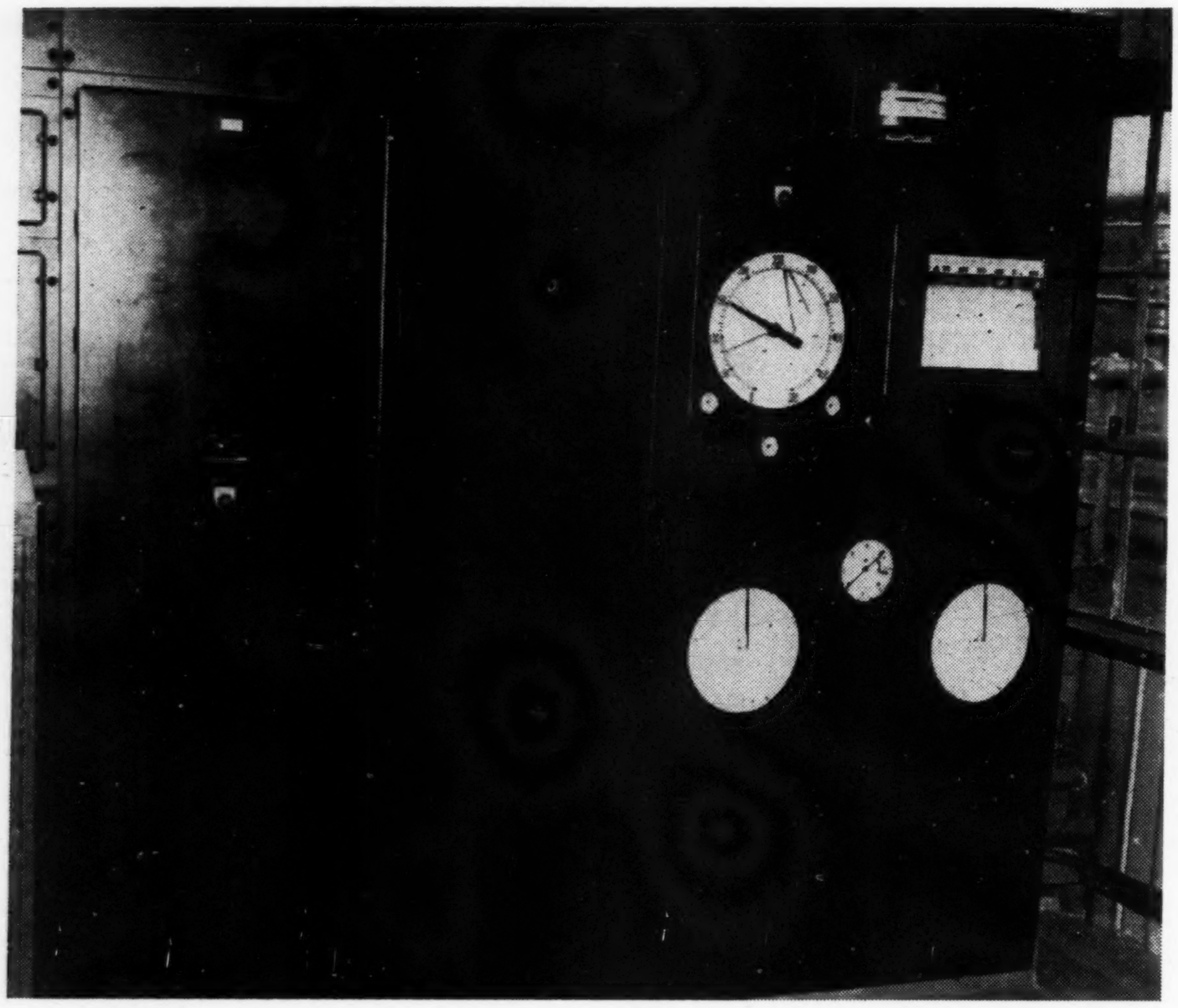


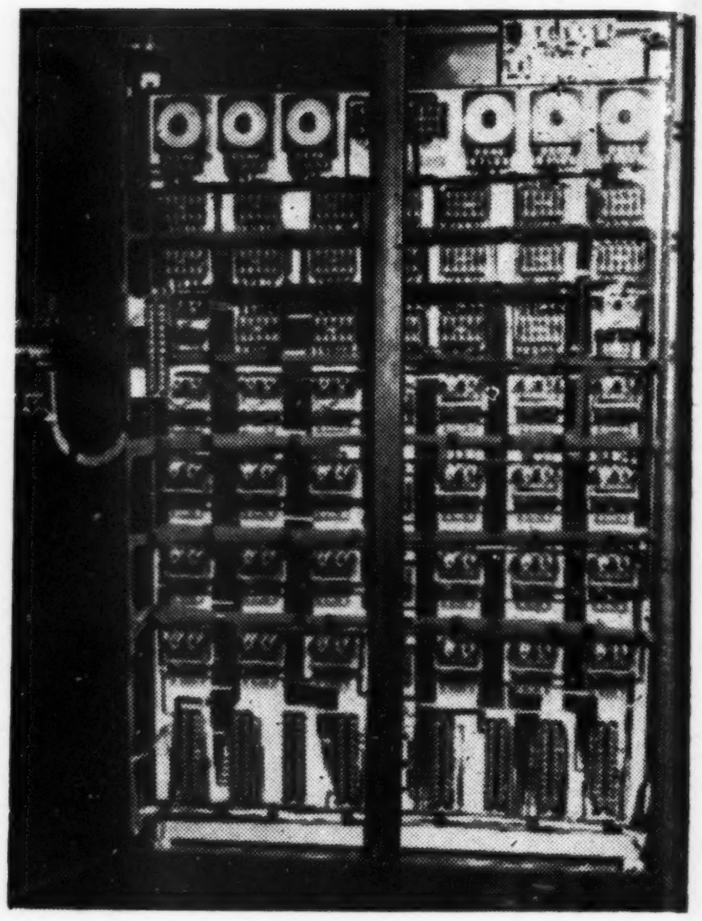


Fig. 9. (Left) Instrument panel at right, automatic timer at left. Fig. 10. (Above) Automatic timer; front panel doors open.

received from Michigan-Wisconsin Pipe Line Co. during the summer and to furnish peak load gas during the winter time to Michigan communities. Gas is withdrawn from the Austin storage field by a compressor station for distribution at pressures as high as 970 psi, and accordingly, sub-zero gas dew-points are required in order to prevent hydrate difficulties in transmission lines and in unheated downstream regulator stations, particularly during the late winter and early spring when frost has penetrated to pipeline depths. Storage field pressures will vary from 400 to 600 psi and flow conditions may vary from an input of 160 MMcf per day to a withdrawal in excess of 200. To meet these varying conditions, it was necessary to provide a positive means of regeneration gas circulation; thus, a regeneration gas circulating compressor was included in the design.

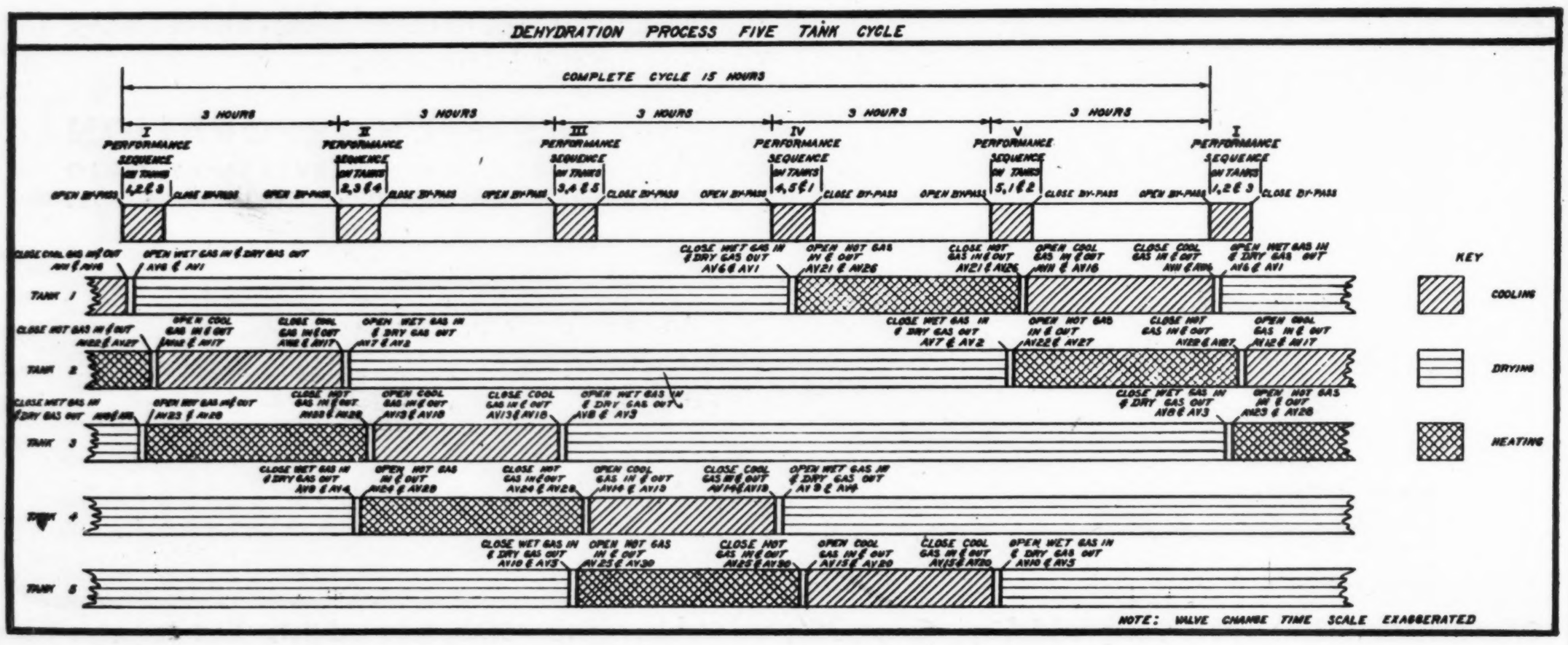
With the exception of the forced circulation regeneration system, the design of this plant is essentially as shown schematically in *Fig. 5* for a five-tower plant. The towers are located in a row with the filling manholes looking away from the headers and the control building. All electrically operated valves and other instruments are controlled from the central control building.

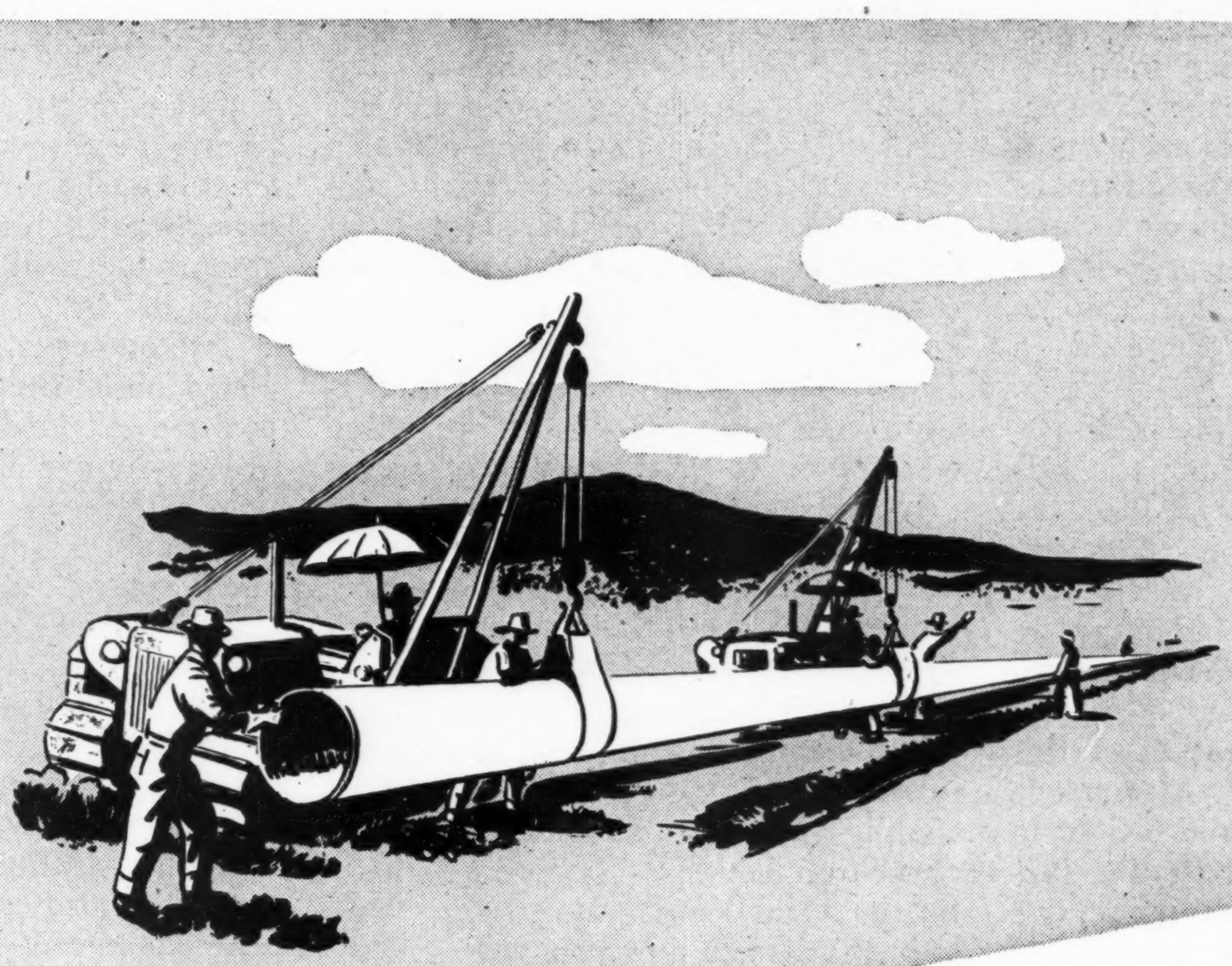
Fig. 6 is an over-all photograph of the plant showing the five towers in a row, the cooling tower, the vertical direct-fired furnace, the compressor building in the background, and the control building in the foreground to the right of the towers. *Fig. 7* is a photograph of the towers showing the motor-operated Nordstrom plug valves with connections to the headers. These valves are equipped with Cutler-Hammer electric motor operators controlled from a Cutler-Hammer sequence timer in the control building.

Fig. 8 shows a section of the manual push button motor operator controls inside the control building. Above this manual control panel is shown an indicating light panel which tells which valves are open, which are closed, and the process being performed on each tower.

Fig. 9 views, at right angles to the manual push button control panel, the instrument panel and the automatic

Fig. 11. Dehydration process, five-tank cycle.





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valve sequence timer doors. Flow pressures and temperatures are indicated and recorded on the instrument panel and furnace safety controls are mounted on the panel. The direct-fired furnace is equipped with safety controls to turn off the fuel and block the process gas flow if (a) the pilot goes out or (b) the furnace stack temperature exceeds a set maximum.

The automatic timer is placed in operation by setting the automatic off-manual switch shown in *Fig. 9* on the left-hand door of the timer compartment. *Fig. 10* is a photograph of the timer compartment with doors open showing timing clocks and sequence relays.

The cycle for the operation of this plant is shown in *Fig. 11*. At any one time there are always three towers in drying service, one tower cooling preparatory to coming on to drying service and one tower heating for removal of water. A basic valve change sequence is employed which repeats at equal intervals of time but which is performed on only three towers, progressively changing one tower for each sequence.

Referring to *Fig. 11*, showing the cycle, Tower 1 has been cooling and is ready to go into drying service. Before closing the cooling valves, a by-pass valve in the cooling system is first opened in order that the series cooling and heating circulating system will not be blocked during the period of valve change. Next the valves carrying cool gas in and out of Tower 1 are closed and the wet gas inlet and dry gas outlet valves are opened, thereby placing Tower 1 in drying service along with Towers 3, 4, and 5. The next valve operation is to take Tower 3 out of drying service and to place it on heating for regeneration. The wet gas inlet and dry gas outlet valves are closed and the hot gas inlet and outlet valves are opened. Immediately after this operation, both Towers 2 and 3 are heating in parallel.

The next operation is to take Tower 2 from heating into cooling. The hot gas inlet and outlet valves are closed and the cooling gas inlet and outlet valves are opened on Tower 2. A continuous path for the series heating and cooling circulating system is now provided and the by-pass valve is closed, completing the sequence.

The automatic timer forms the valve change sequence on the basis of a time interval, which time interval is adjustable manually between one hour and six hours. With such adjustment the time interval may be selected to provide the required dehydration capacity. As a matter of practice the cycle is set between two and three hours and is very seldom changed regardless of load. For future increases in capacity the cycle length can be reduced downward from three hours. This plant produces a dry gas product with a dew point of 15°F below 0.

Two other plants have just been completed based on the same design. One is Goodwell field dehydration plant of Michigan Consolidated Gas Co. in Michigan. A larger plant for processing Hugoton field gas at 1000 psi has recently been placed in service in Hansford county, Texas, for Michigan-Wisconsin Pipe Line Co.

The writer desires to express appreciation and to acknowledge the assistance of Michigan Consolidated Gas Co. and Michigan-Wisconsin Pipe Line Co. in the preparation of this article. Appreciation is also expressed to individuals who have granted permission to reproduce data herein.

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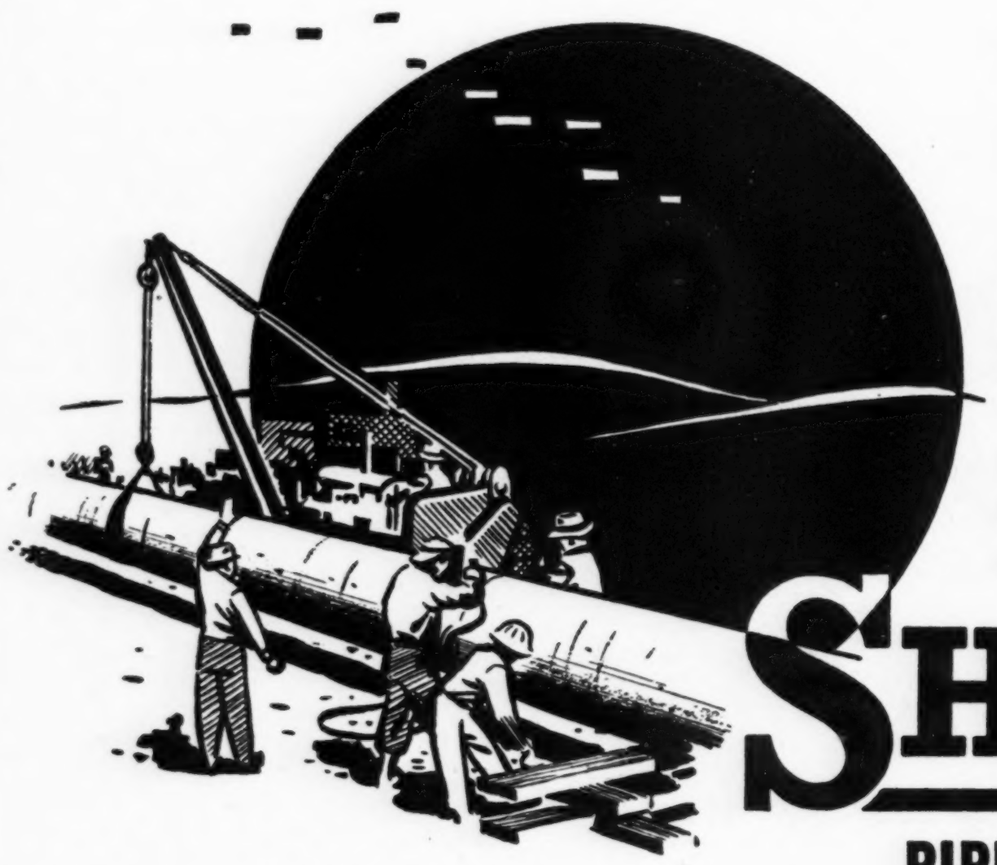

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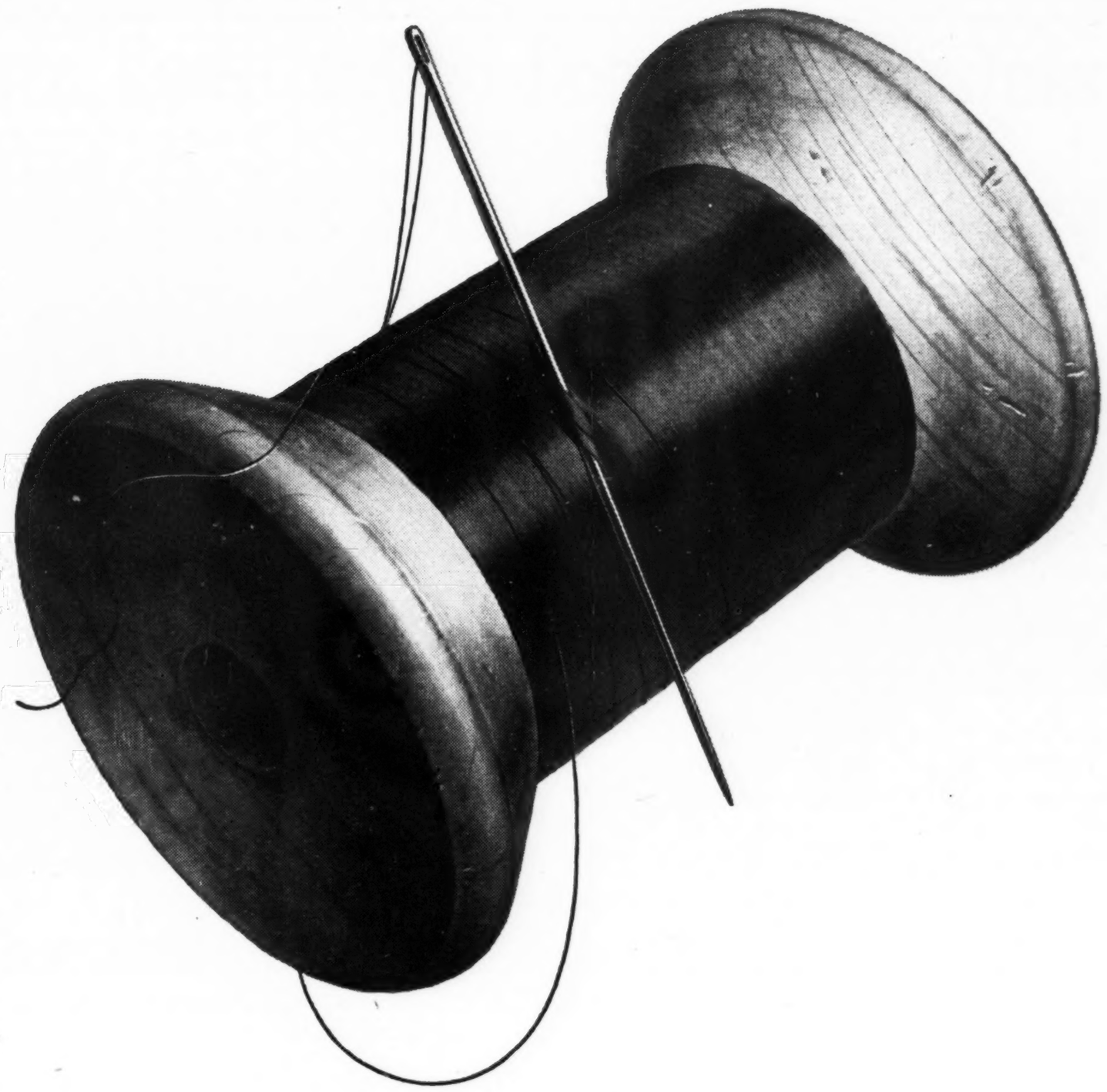

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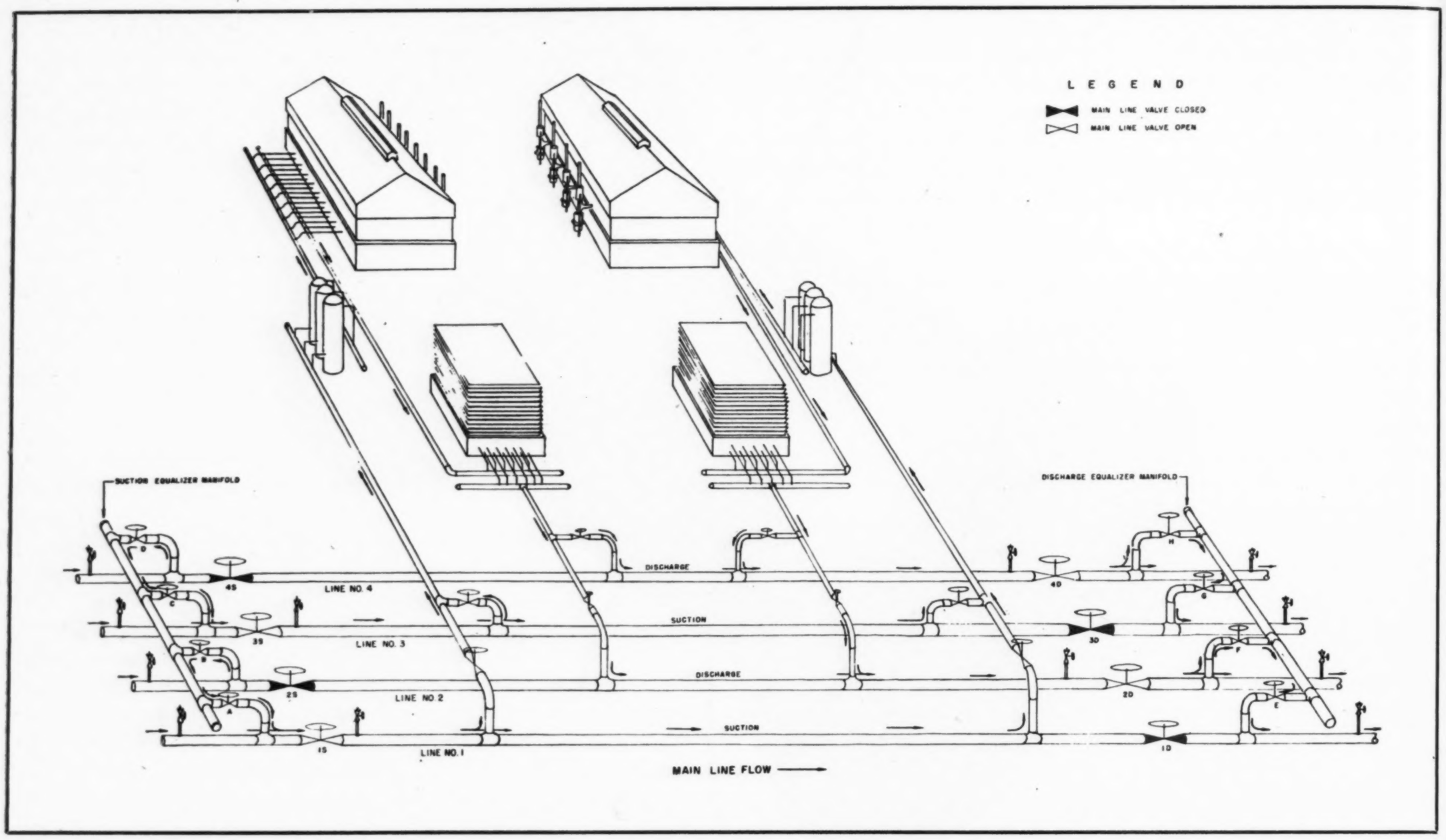


New arrangement of valves and pipes at Tennessee Gas Transmission compressor stations.

TGT Re-Designs Manifold System, Simplifies Booster Station Tie-Ins

By Craig Espy

TENNESSEE Gas Transmission Co., Houston, because of the rapid increase in amount of gas carried through its line, is planning to introduce some new design principles in the arrangement of pipe and valves at its compressor stations.

Exclusive

Details of the new design have been explained to *GAS* by Joe J. King, chief engineer, and Burton Mast, acting supervising engineer.

The company launched a $100 million construction program early in April. This program is designed to increase the system capacity to 1060 MMcf per day as authorizcd by the FPC.

The extension part of the program will include the laying of 26-in. steel pipeline across 21 counties in Kentucky, Ohio, Pennsylvania, and New York, to a point near Buffalo, 1750 miles from where the line originates on the Gulf of Mexico. The company's application for extension of its line still farther east is awaiting final FPC action, and this would involve even greater deliveries of gas.

Expansion Headaches

The company's vast present and prospective expansion means new engineering problems. One such problem has been encountered in the design of the pipe and valve arrangement at compressor stations. The conclusion has been reached that by the time there are four pipelines and several additional sets of compressor facilities at compressor stations, the operation of these facilities would become extremely complicated.

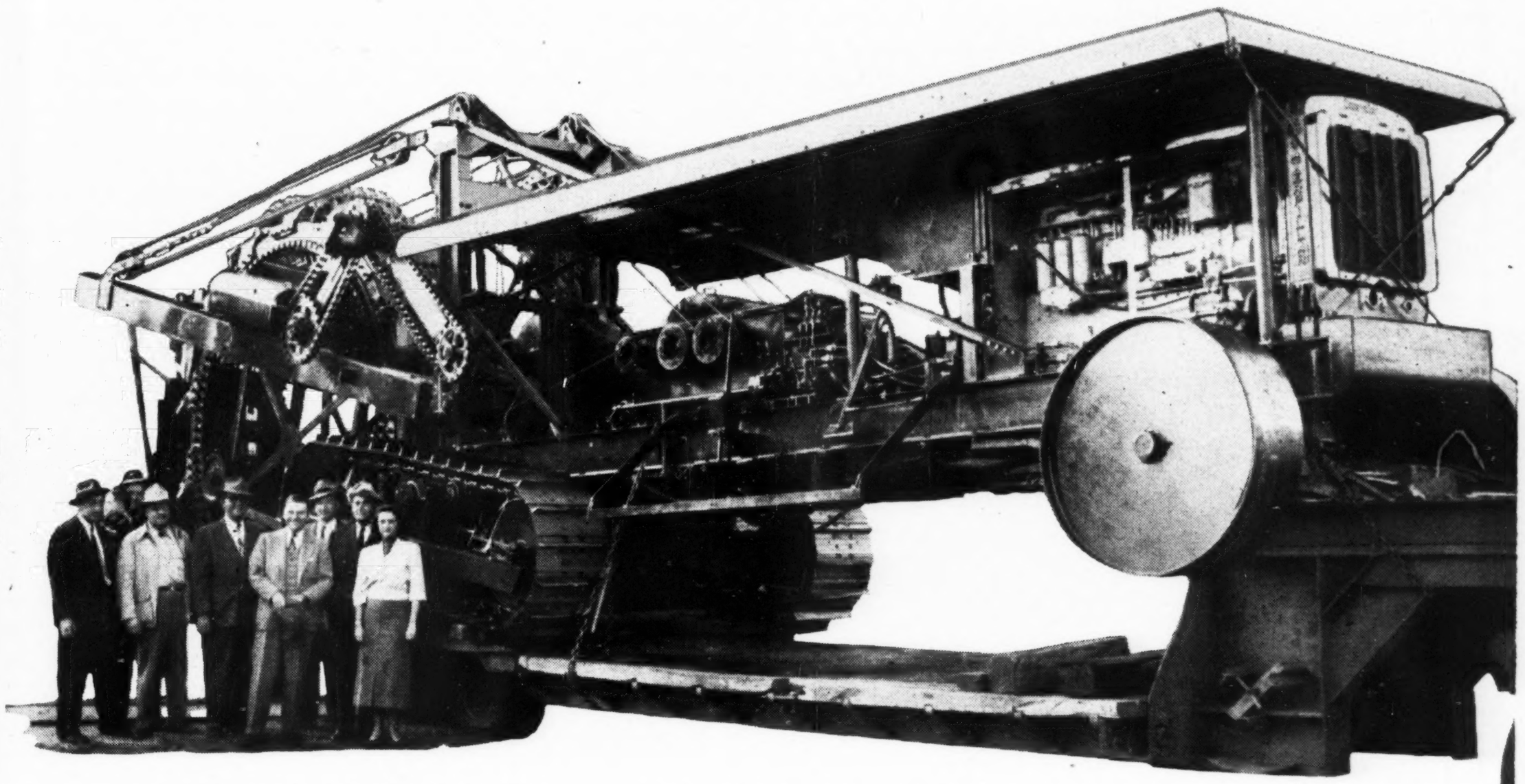
The company's engineers went to work on this challenging problem and developed a solution which is shown in the accompanying diagram. The new system and the difficulties presented by endeavoring to continue the old system were described as follows by Mr. King.

"Expansion of the Tennessee Gas system in laying additional loop lines and installing new compressor buildings at existing compressor stations has considerably complicated the piping at the stations in tieing in each compressor building to each of the pipelines. General practice in the industry has been to install a single block valve on the main line and a suction and discharge side valve into the plant. Consequently, when a new compressor building is installed it would become necessary to run a large number of equalizing lines through the plant yard to tie in each pipeline to each of the buildings.

The New System

"For example, to tie four compressor buildings into the suction and discharge side of the block valves of four pipelines would require a total of 32 suction and discharge valves in order that each building could take suction from and discharge into each pipeline. Inasmuch as many of these valve settings would have to be made on operating lines, it would be necessary that many be in-

Eastern Construction Company Christens New Big Incher Ditcher Before Placing It in Service on Mid Valley Pipe Line



Assisting in the dedication of the ditcher were left to right, front row: J. W. Arthur, vice president Eastern Construction; Grover Swartz, Crutcher-Rolfs-Cummings; A. S. Crutcher, Crutcher-Rolfs-Cummings; Ray E. Carter, Unit Rig & Equipment Co.; C. Hobson Dunn; Mrs. Carmen Dunn Schumacher; Back Row: Fred Byers, general superintendent, Eastern Construction, holding his son, Bob; William Guier, Unit Rig & Equipment Co.

Mrs. Carmen Dunn Schumacher, daughter of C. Hobson (Hobby) Dunn, president of Eastern Construction Co., Inc., Dallas, christened in Tulsa, Oklahoma, April 7th, the "Big Incher," first big ditching machine ever made in the Mid-Continent area and the biggest wheel type ditcher ever constructed anywhere. The ditcher is the first model of Crutcher-Rolfs-Cummings, new, improved line of ditchers manufactured by Unit Rig & Equipment Co., of Tulsa.

After christening the ditcher, it was loaded on a large flat car and shipped to Henderson, Tennessee, near which Eastern is laying 155 miles of big inch pipe for Mid Valley Pipe Line Co.

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stalled as hot tap valves to minimize plant and pipeline shut-down time. Because of excessive shut-down time, and the large number of valves that would have to be operated to isolate the plant from the main pipeline system in the event of an emergency, it was decided to re-design the station pipe manifolding system. The new system will be installed and operated in the following manner:

"Referring to the sketch, two main line block valves will be installed on each pipeline as shown by valves marked 1-S on the suction side of the plant and 1-D on the discharge side of the plant on Line No. 1. Similar valves are on lines 2, 3 and 4. On the pipeline side of the block valves, an equalizing manifold is to be installed and tied into each of the pipelines.

"In operation, two of the lines through the plant yard will be used as suction lines or will carry gas at suction pressure. In this particular instance, they will be Lines Nos. 1 and 3. To accomplish this, Valves 1-S and 3-S will normally be in an open position and Valves 1-D and 3-D will normally be closed. Two lines will be discharge lines to carry gas at discharge pressure, and in the drawing are represented by Lines Nos. 2 and 4. To accomplish this, Valves 2-D and 4-D will normally be in an open position and the Valves 2-S and 4-S will normally be in a closed position.

"In operation, gas entering the plant in Line No. 2 will flow into the equalizing manifold through Valve B, across the manifold, through Valve A and to Line No. 1, merging with the gas stream in Line No. 1. The combined gas stream will then flow down Line No. 1 to the various scrubber tie-in connections. Similarly, the gas stream in Line No. 4 will flow into the suction equalizing manifold through Valve D, across the manifold and into Line No. 3 through Valve C. The combined stream of Lines 3 and 4 will then flow down Line 3 to the scrubber tie-in valves. On the discharge side of the plant, the gas from the cooling towers will be turned into Lines No. 2 and No. 4, flowing through Valves 2-D and 4-D and be distributed to the four pipelines, leaving the plant through the discharge equalizing manifold in a manner similar to the flow in the suction equalizing manifold.

Manifold Advantages

"This manifold system has the following advantages:

1. A new compressor building can be located anywhere between the two main line block valves and can be tied into two suction and discharge lines without the necessity of running equalizing lines.
2. New station tie-ins or repairs to old lines can be made cold inasmuch as any one of the four lines between the block valves can be shut down with the pipeline system and the plant operating on the remaining lines, thereby eliminating the necessity of using smaller sized hot-tap valves.
3. All gas entering and leaving the plant passes through four valves, Nos. 1-S, 3-S, 2-D, and 4-D, and if each of these four valves is made either automatic or remote control operated, the gas can be quickly shut off and removed from the plant piping in the event of an emergency within the station. In the previous design it would be necessary to use up to 32 remote control valves to effect an emergency shut down.
4. The main line block valves can be located as far apart as desired; therefore, they can be installed at a sufficient distance from all plant operating equipment so as to be easily reached without danger in the event of fire or explosion within the plant proper.
5. Additional pipelines can be tied into the suction and discharge equalizing manifolds without the necessity of running the lines completely through the plant yard."

PARKHILL is *"Stringing Along"* with the Gas Industry

NEW CONTRACTS AWARDED PARKHILL

Company	*Miles*	*Size*
Montana Power Co. — Bozeman to Butte, Montana for Deaton & Sons, Inc.	150	12"
Interprovincial Pipe Line Co. — Duluth, Minn. to Gretna, Manitoba for Anderson Brothers Corp.	340	18"
Northern Natural Gas Co. — Nebraska, Iowa, Minnesota for Midwestern Constructors, Inc.	200	26"
Salt Lake Pipe Line Co. — Baker, Ore. to Pasco, Wash. for Pacific Pipe Line & Eng. Ltd.	120	8"
TOTAL	820	

PARKHILL JOBS NOW UNDER WAY

Transcontinental Pipe Line Co. — S. Carolina to New York for Smith Contracting Corp.	200	30"
Mid-Valley Pipe Line Co. — Tennessee and Kentucky for Britton Construction Co.	110	22"
Mid-Valley Pipe Line Co. — Ohio for Mahoney Construction Co.	120	20"
Salt Lake Pipe Line Co. — Boise, Idaho to Baker, Oregon for Morrison Knudsen Co., Inc., Bechtel Corp.	120	8"
TOTAL	550	

PARKHILL TRUCK COMPANY is not only moving along with the Gas Industry in its effort to keep pace with growing industrial and domestic use of natural and manufactured gas in all sections of the country; it is moving a lot of pipe for new lines now under construction.

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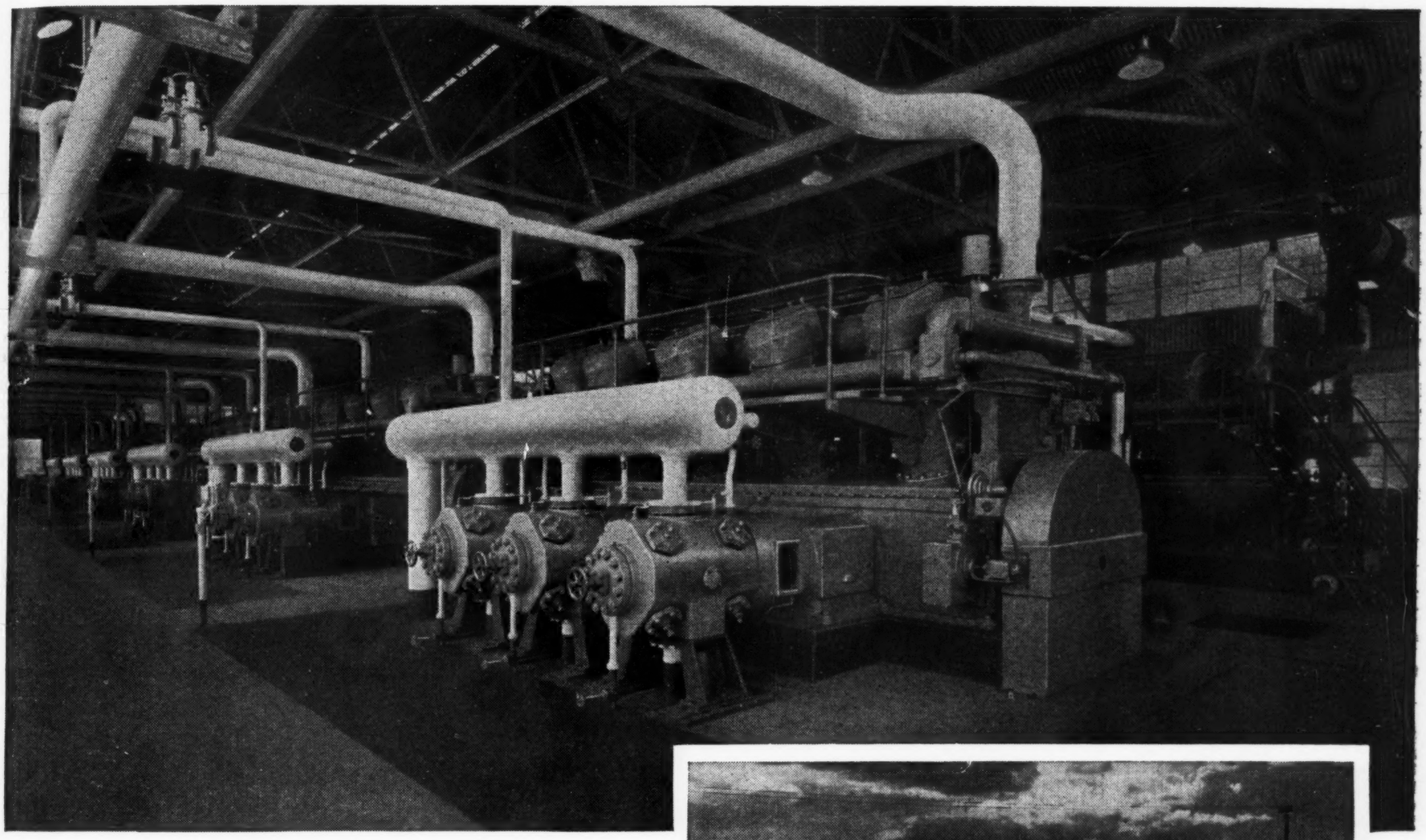

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ALBERTA WRANGLE

Three export pipeline cases due for hearings

As the Province of Alberta (Can.) this month mulls over the problem of whether it should permit export of its natural gas to the Northwestern United States, and if so who should be permitted to carry it, the probabilities that a decision favorable to the utilities of the Pacific Northwest will be rendered appear stronger than ever.

The chief stumbling block has been the question of reserves, but sensational new findings in recent months have all but silenced the opposition on this score. Last year the so-called "Dinning Commission," set up to study the reserves situation, came forth with a figure of 4.26 trillion cu ft. But since then gelogists and gas engineers retained by Westcoast Transmission Co. Ltd., one of the pipeline applicants, have located an additional 3.49 trillion, giving an aggregate proved reserve of well over 7 trillion. In recent hearings on the Westcoast case, it was declared that 5.497 trillion is marketable.

Out of this, only 1.2 trillion would be needed to serve the Westcoast market for 20 years. Furthermore, as has been the experience in the United States, as more wells are drilled, more gas will be found, and during the next few years, according to one expert, exploration may uncover another 5 trillion.

This same expert brought forth evidence to show that, based on probable growth of Alberta's population, saturation increase, and a comfortable cushion, the province's needs for the next 50 years will not exceed 2.78 trillion.

This evidence was brought to light in recent hearings on the Westcoast Transmission Co. Ltd. application. First hearings were held from Jan. 30 to Feb. 16, then adjourned to April 11.

Northwest Natural Gas Co.'s case, proposing a pipeline which would take off through Idaho, ending up in Seattle, Portland, and Vancouver, was docketed for April 23. Western Pipelines Ltd.'s plea for a line from Alberta to Winnipeg, Man., thence south to the Dakotas and Minnesota, is set down for June 19.

Westcoast appears to have a strong case. It calls its line the "All-Canadian" route, thereby establishing that (1) the people of Alberta will have first call on the gas, and (2) surplus Alberta gas will serve Canadians before any is taken out of the country.

Westcoast is not resting on its well-founded argument that there is plenty of gas for everyone, but is pointing out these benefits to Canada itself:

The gas gathering systam which would be built would link up the gas fields with present Alberta distribution systems, providing increased service; with markets provided, exploration would be accelerated; the gathering system would provide a source of supply for the system east to Winnipeg, one of Canada's largest cities; new industry would be encouraged in Canada—rolling mills, valve, tank, and fitting manufacturers, for example—needed to build and supply the line; more U. S. dollars would flow into Canada; more Canadian employment would result — in building the line and in maintaining it; national defense would be strengthened through distribution of vital fuel requirements to strategic centers on the Pacific Coast.

Westcoast's main line would stretch out for a distance of 1025 miles, with an additional 119 miles of laterals and 426 miles of gathering lines for a total of 1570. From Edmonton to the international border, 725 miles, and from the border to Wickersham, Wash., 24-in. pipe would be used. A 40-mile, 14-in. line would take off from near Chilliwack to serve Vancouver, B.C. From Wickersham to Portland, the main line would narrow down to 22-in.

In Washington, Seattle, Bellingham, Tacoma, Olympia, Centralia, Everett, Kelso, Longview, and Camas would be served, as well as Portland, Ore.

Total cost is estimated at $114 million, of which $95 million would be expended in Canada and $19 million in the United States.

How cities not on the route of the main line would nevertheless benefit was brought forth by Westcoast in its application. Calgary and Edmonton, for example, would be one the route of gathering lines, which would supply all future requirements. Furthermore, complete pooling of all gas resources in the province would be accomplished, as recommended in the Dinning Commission's report.

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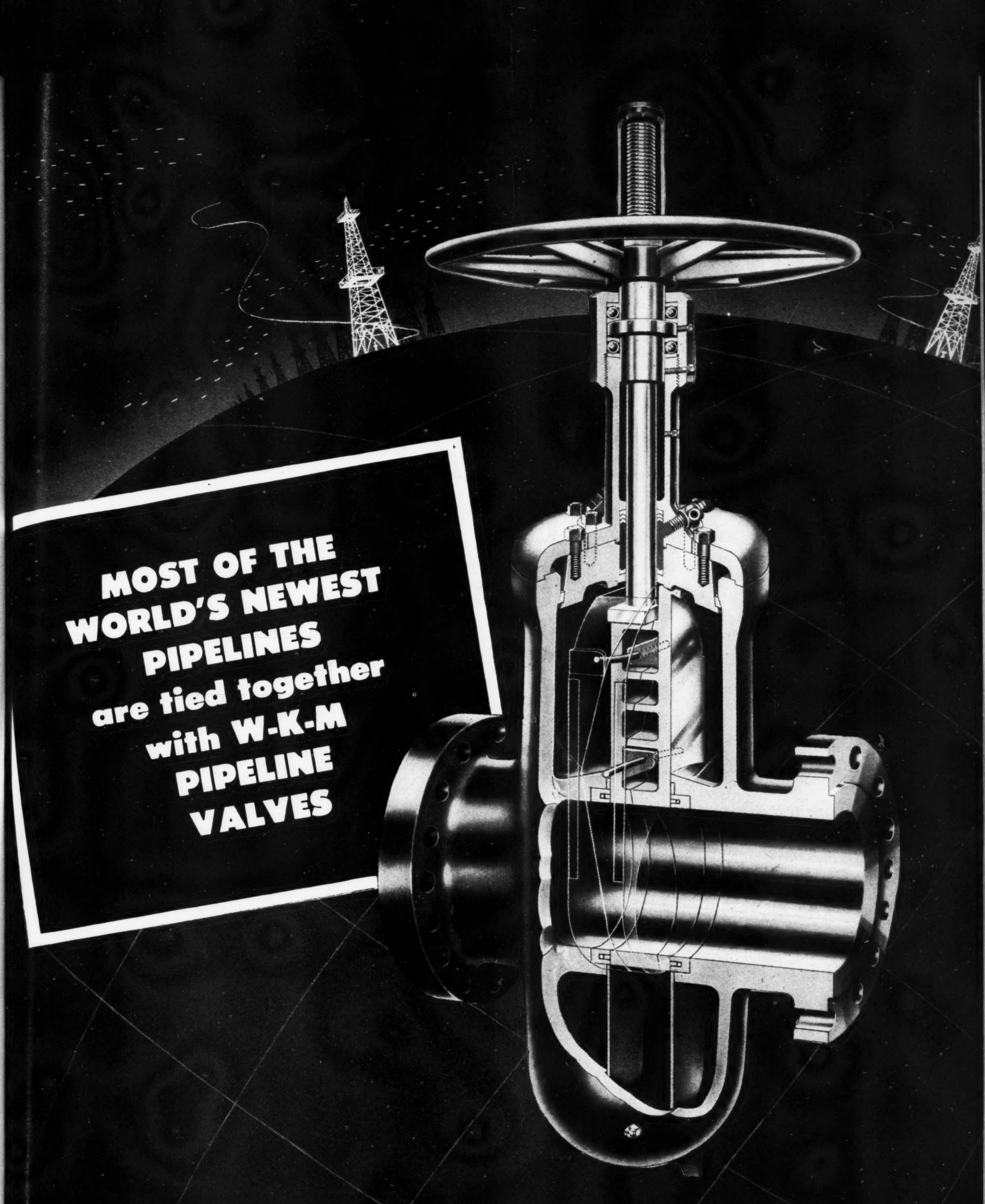

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PIPELINERS ORGANIZE

New SGA section holds first convention meet

Emphasizing the great importance of transmission matters to a growing number of members of the Southern Gas Assn., the new Transmission Section of the association held its first "legalized" meeting as a separate part of the association during the convention at Galveston March 27-29.

The Transmission Section has sprung full-grown in a short time. This year it held the largest panel of the entire convention.

Twenty-one experts and a crowd which overflowed the solarium at the Buccaneer hotel carried on a symposium which took up in informal question and answer discussion some principal pipeline problems.

At another session of the section, Paul Kayser, president of El Paso Natural Gas Co., presented an enlightening paper on "The Effect of Oil Proration on the Marketing of Flare Gas."

Actually the section was formed during the past year, and at this year's meeting Carl E. Cloud of Oklahoma Natural Gas Co. reviewed the steps leading to its formation.

Mr. Cloud mentioned that interest in transmission was dramatically demonstrated at the association's meeting in Galveston two years ago. At that time there was nothing like the present formal section, but informal arrangements were made for a transmission group to meet. The group was set up in a room to accommodate about 60 people, Mr. Cloud continued.

"As 2 p.m. approached," he recalled, "it became evident that it would be necessary to secure additional space. Fortunately the hotel was able to provide an adjoining room, with a capacity of 130. But many desiring to attend were unable to do so.

"The following year, the first regional transmission committee meeting was held in Shreveport, under sponsorship of Jim Yeldell of Southern Natural.

"Southern Gas regional meetings are dubbed 'grass roots meetings' and the goal is for a group of men actively engaged in the supervision of similar work to get together and discuss their problems and conclusions.

"The panel discussion at this year's Galveston meeting, with E. R. Cunningham of Texas Eastern Transmission Corp. presiding and Frank S. Kelly Jr., of Louisiana Natural Gas Corp. as moderator, presented a panel of 21 specialists on transmission operating problems, divided under the following headings: Rights-of-way, measurement and regulation, corrosion, construction and maintenance, compressor stations, dispatching, communication, purification, and gas supply.

Mr. Kayser, president of El Paso Natural, in his discussion of the effect of oil proration on marketing of flare gas, suggested that a full-scale hearing might be needed to settle some of the problems connected with this subject.

NACE Conference And Show Attracts 900 To St. Louis

The National Assn. of Corrosion Engineers continued to prove itself a vital, growing group this spring when more than 900 from the far-flung branches of the field attended its Sixth Annual Conference and Exhibition in St. Louis, April 4-7.

The meeting, in addition to providing four days of discussion of up-to-the-minute technical problems, provided an opportunity for those attending to see the wide variety of exhibits by leading manufacturers who serve the corrosion field.

Symposia were held on the different phases of corrosion, including the problem as related to the chemical industry, cathodic protection, oil and gas industry, transportation industry, protective coatings, fresh and salt water corrosion, and pipelines.

On the last day of the meeting there were two round tables, one on pipeline protection with F. J. McElhatton of Panhandle Eastern Pipe Line Co., Kansas City, Mo., and R. L. Bullock of Interstate Pipe Line Co., Tulsa, as chairman and co-chairman.

The gas industry was represented by a large number at the meeting.

The Cathodic Protection Symposium was well attended with the following as chairman and co-chairmen: Robert J. Kuhn, consulting engineer of New Orleans; Sidney E. Trouard, New Orleans Public Service, and H. A. Robinson, Dow Chemical Co., Midland, Mich.

William L. Crosby of Consolidated Edison Co. of New York delivered a paper at the Protective Coatings Symposium on use of cathodic protection in conjunction with paint coatings.

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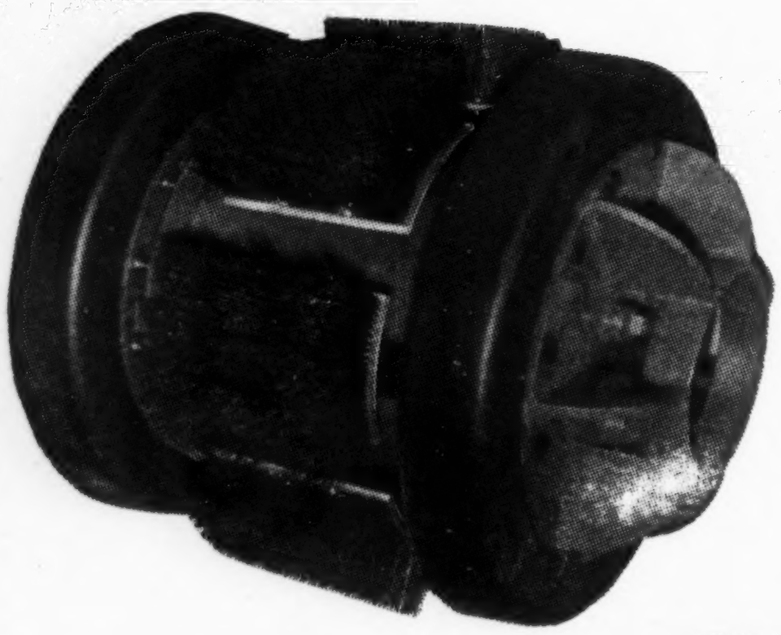

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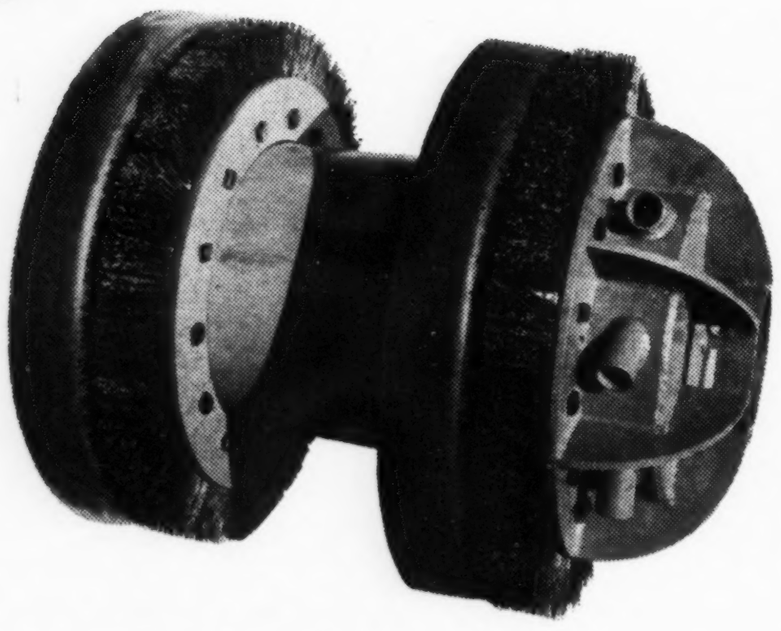

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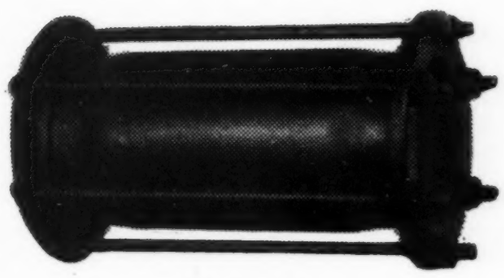

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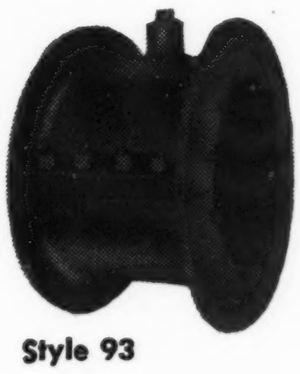

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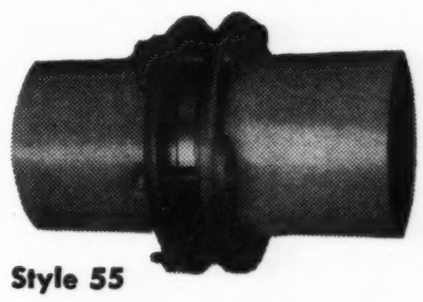

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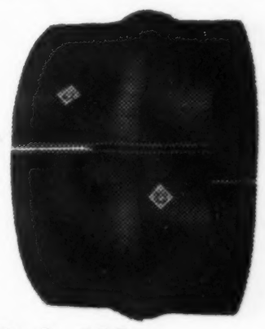

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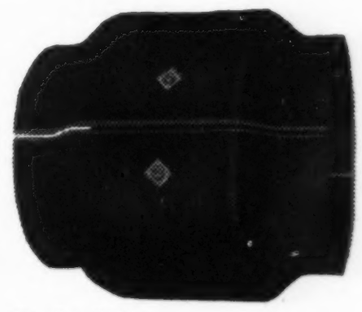

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SAN JUAN HEARING

Five intervenors prepare testimony

Reopened hearings on the proposed pipeline which El Paso Natural Gas Co. would build from the San Juan basin of Utah, Colorado, Arizona, and New Mexico, to carry gas to the California-Arizona border for further transmittal to San Francisco, got under way April 17 with intervenors grabbing the limelight.

In an 11th-hour move, Southern California Gas Co. and Southern Counties Gas Co. petitioned for and were granted intervention. This action on the part of two southern California companies was taken in an effort to checkmate Interstate Natural Gas Co., which on April 12 was granted permission to intervene. Interstate (no relation to another company by the same name), which previously had been allowed to intervene and then had the order rescinded, seeks to have El Paso and the California companies declared "common carriers" and thereby force them to carry its gas from the Permian basin through the various Texas-to-California lines to serve consumers in direct competition with them. (*GAS*, March, p. 86.)

An intervention petition introduced by Nevada Natural Gas Pipe Line Co., Las Vegas, which proposes to carry natural gas from a connection with the El Paso line at Topock, Ariz., through California (serving Needles) and into Nevada, to supply Las Vegas, Boulder City, Henderson, and other areas, was approved.

A fifth intervenor would be southwest Gas Corp.—if its plea were to be granted. This company wanted to serve Barstow, Victorville, and adjoining areas in eastern California.

An atmosphere of suspense was created in the FPC hearing room when Interstate's attorneys did not appear on opening day. It was announced that a second law firm would represent the company, but the new lawyers, Eugene Carusi and Thurman Hill of Barnes & Hill, did not appear until Thursday, April 20.

Early testimony centered about the question of adequacy of San Juan reserves and the supply position of El Paso Natural.

J. F. Dougherty, DeGolyer & McNaughton, Dallas, presented maps and testimony to show that reserves are sufficient.

El Paso President Paul Kayser recited the hard facts his company faces in relation to Permian basin supplies. Availability is determined by market demand for oil, not gas, he pointed out. Residue gas will not meet winter peaks because the supply is larger in summer than in winter. Present Texas proration rules do not permit making up allowable for one month in the next, and if a monthly proration order permits only 20 days' oil production, the tendency of operators is to produce the total in the first 20 to 25 days, and shut down for the remainder of the month.

"If oil producing days are cut by just one day, that means 20 MMcf less gas," he said. "This must be met from dry gas production." Pending possible rectification by the Texas Railroad Commission, "we must install sufficient dry gas capacity (meaning San Juan field gas) to meet all peak demands."

If the current application is granted, plans call for sending a total of 750 to 800 MMcf per day of flare gas to California. The San Juan line would be operated at full capacity —167 MMcf—in the winter, and could be cut back to as little as 10 MMcf in the summer by shutting down compressor stations, he declared.

If the proposition fails to win approval, El Paso would have to store huge quantities in the summer, said Mr. Kayser. No more contracts to take flare gas could be made.

E. C. McKeage of the California Public Utilities Commission told interviewers rationing of gas might have to be instituted if the additional gas is not brought into California.

Boyd Heads New Firm

William R. Boyd Jr., Teague, Texas; Major B. A. Hardey, Shreveport, La.; and R. L. Wheelock, Corsicana, Texas, have joined forces under the firm name of Boyd, Hardey & Wheelock, to arrange the purchase or sale of oil or gas producing properties and the merger of oil or gas companies or individually owned oil or gas interests.

The headquarters office of the firm will be located in Teague, and Mr. Boyd will be the managing partner.

Mr. Boyd is a consulting attorney and petroleum-consultant-advisor. For 29 years he was an official of the American Petroleum Institute. After serving eight years as president, he retired Nov. 9, 1949.

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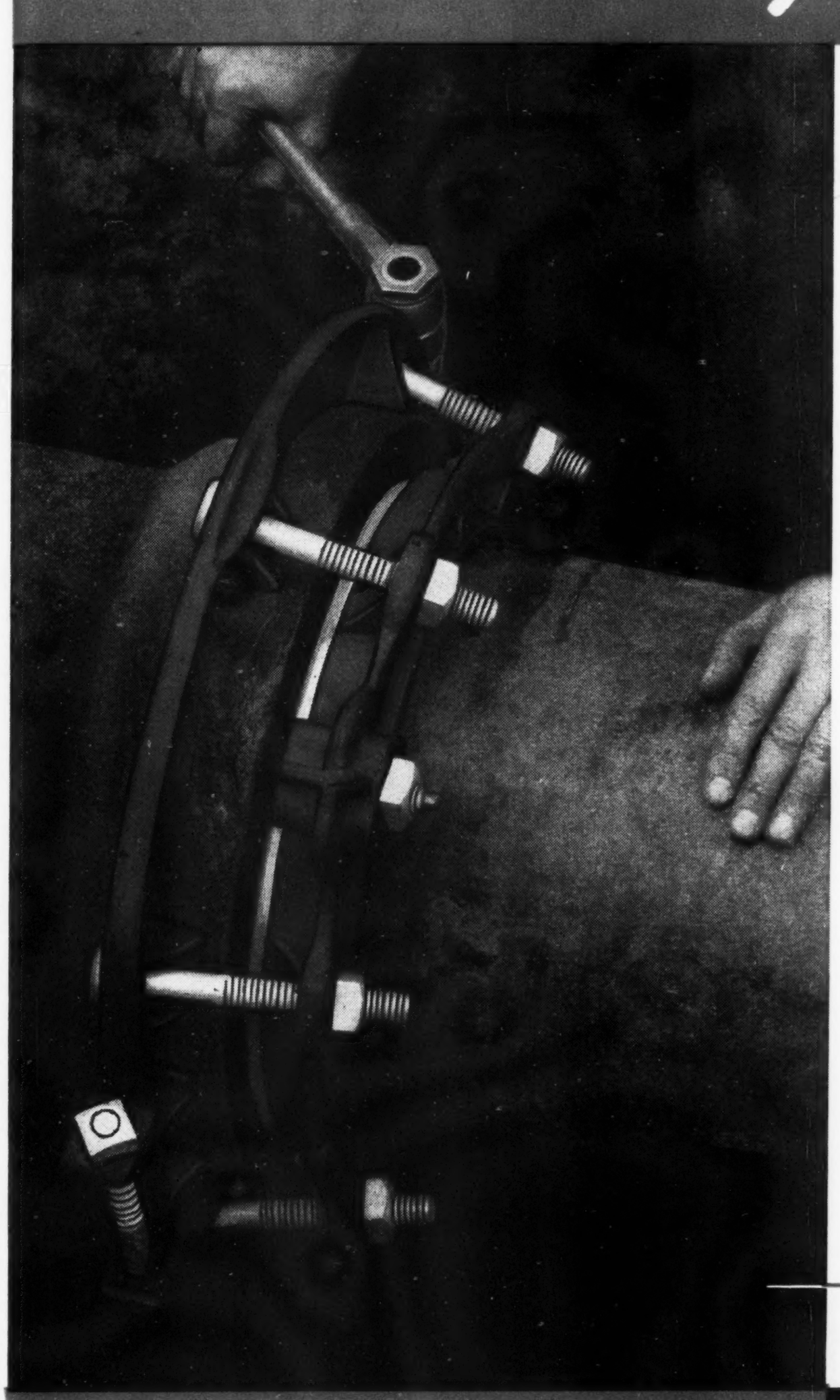

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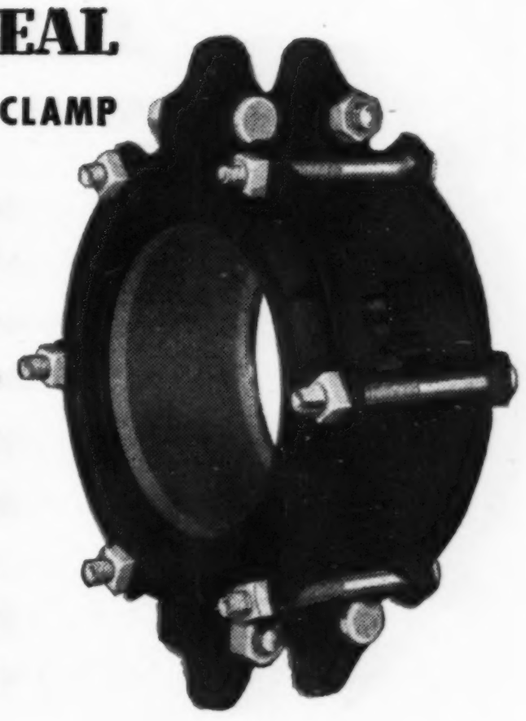

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SKINNER-SEAL BELL JOINT CLAMP

John G. Staudt, executive vice president of Dowell Inc., cathodic protection experts, awarded safety plaques to managers of four winning districts at a spring conference in Tulsa. Receiving the honors for safety records from Mr. Staudt are, from left, W. S. Day, Mt. Pleasant, Mich.; Jack Sutherlin, Wichita Falls, Texas; Jim A. Cummin, Wichita, Kan., and Charles L. Power Jr., New Orleans.

Commonwealth Wins Right To Serve Virginia Cities

Richmond, Norfolk, and other major cities in Virginia have now been added to the ranks of natural gas users, but North and South Carolina will have to wait a bit longer.

Such was the decision of the FPC late in March when it awarded the certificate for the right to serve the Virginia markets to Commonwealth Natural Gas Corp., Lynchburg, Va., after a heated battle between Commonwealth and its rival, Piedmont Natural Gas Corp.

Concurrently cutting off the application of Piedmont, whose line would sweep up the eastern seaboard and bring natural gas to the Carolinas as well as Virginia, the commission took cognizance of the needs of the other two states by reopening the case insofar as service to their areas is concerned.

FPC intimated that its decision was heavily influenced by the fact that because of Piedmont's present agreement for sale to Duke Power Co., it "is not contractually free to offer natural gas on terms and under conditions sufficiently favorable" to all classes of consumers.

The Commonwealth plan will include the receipt of 55 MMcf per day from Virginia Gas Transmission Corp., Charleston, W. Va., at a connection in Greene county, Va. At a cost of $6,425,000, Commonwealth will build facilities designed to serve Richmond, Norfolk, Petersburg, Hopewell, Portsmouth, Suffolk, Newport News, and the Solvay Process plant of the Allied Chemical & Dye Corp., Hopewell.

Virginia Gas was given permission to build metering and regulating facilities at the transfer point, and Tennessee Gas Transmission Co., Houston, was directed to sell 20 MMcf per day to United Fuel Gas Co. for resale to Virginia Gas for resale to Commonwealth.

Construction will commence by July 1.

Piedmont was given 60 days to amend its application and provide further evidence, on several counts, of its ability to serve the Carolinas. It must prove it has commitments for enough gas to supply future requirements; it must overcome the objection that 93% of its first year's supply and 76% of its fifth year's were to be sold to Duke.

Two other applications were affected by the decision—Eastern Natural Gas Co.'s and Virginia Natural Gas Co.'s. Both companies were permitted to withdraw their petitions to serve Virginia markets.

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Pipeliners are welcoming another new pipe mill—the recently completed Kane Boiler Works Inc. plant in Galveston, Texas.

Big-inch line pipe—up to 36 in.—is now coming off the line in limited quantities. Designed capacity of the plant, which will soon be attained, is 10,000 tons per month of 40-ft. sections of tube in sizes from 12¾ in. to 36 in.

President Joseph J. Kane points out that the existence of a mill in such close proximity to major lines now being constructed or in the planning stage will greatly simplify transportation problems.

Southern Counties On Submarine Patrol Near Long Beach

Submarine pipeline patrolling is the latest twist in pipeline operations of Southern Counties Gas Co. Last month the Los Angeles utility sent a diver down to make an under-sea inspection of the 16-in. line that crosses Cerritos channel and supplies the Edison Co.'s Long Beach steam plant at Terminal Island.

The survey was necessitated by the sinking of Terminal Island, which is settling at a rate of about 1 ft a year. It was felt that the line might have heaved up out of its ditch as a result of the earth movement.

Company surveyors guided the course of the diver's boat directly over the submerged pipeline by setting up targets at each bank and then by means of triangulation, directing the pilot with radio equipment. A weighted line was dropped from the boat to guide the diver who took soundings in the mud to check the depth and placement of the line.

Results were good. The line had not shifted.

Loop Program Certificated

New York State Natural Gas Co., a subsidiary of Consolidated Natural Gas Co., New York City, has received FPC's nod on its plan to expand its existing transmission system and underground storage to meet 1951-54 requirements of existing customers.

Included in the $2.6 million budget is a 53.5 mile, 16-in. loop running from Greene county, Pa., to Westmoreland county.

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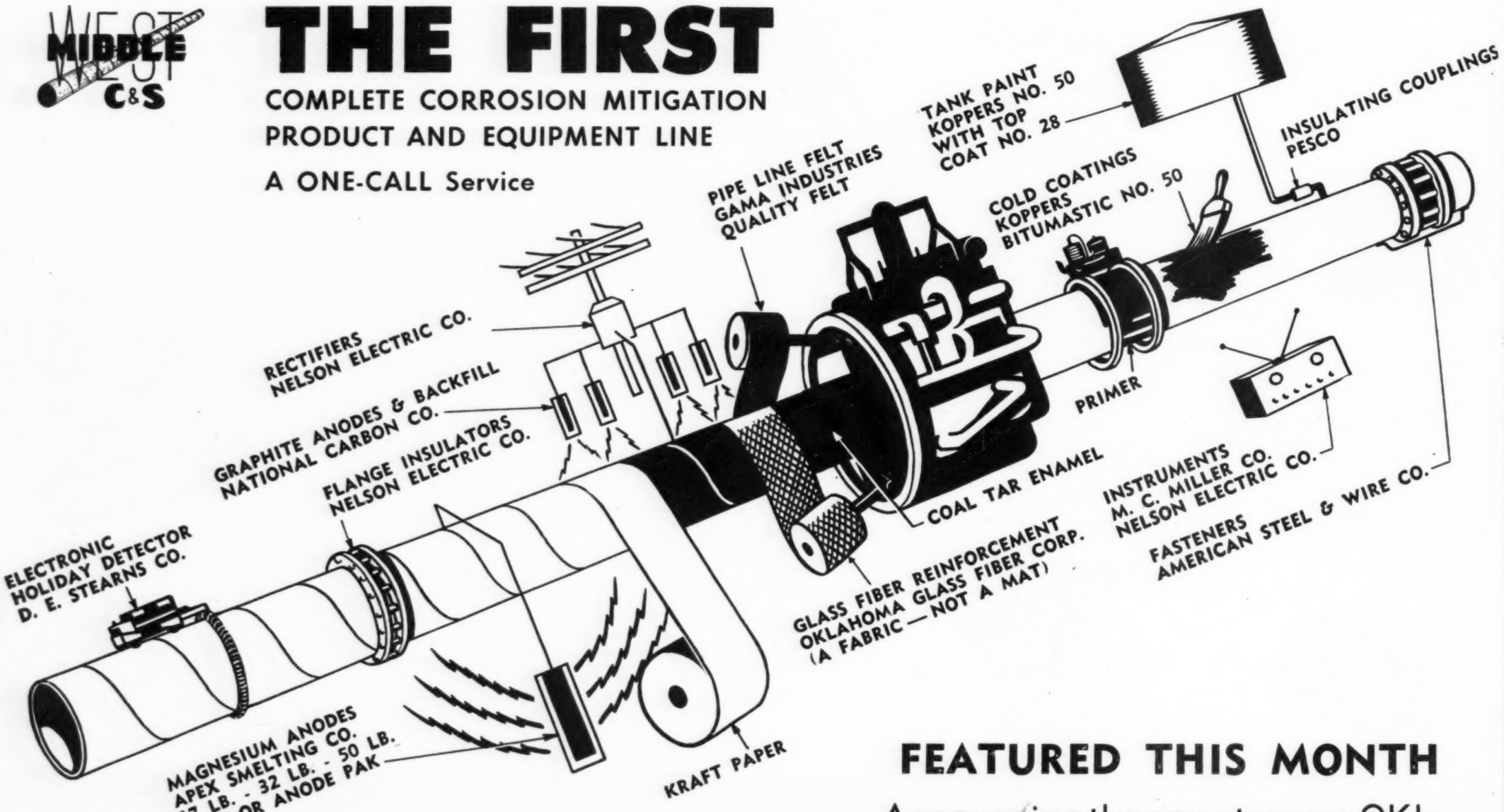

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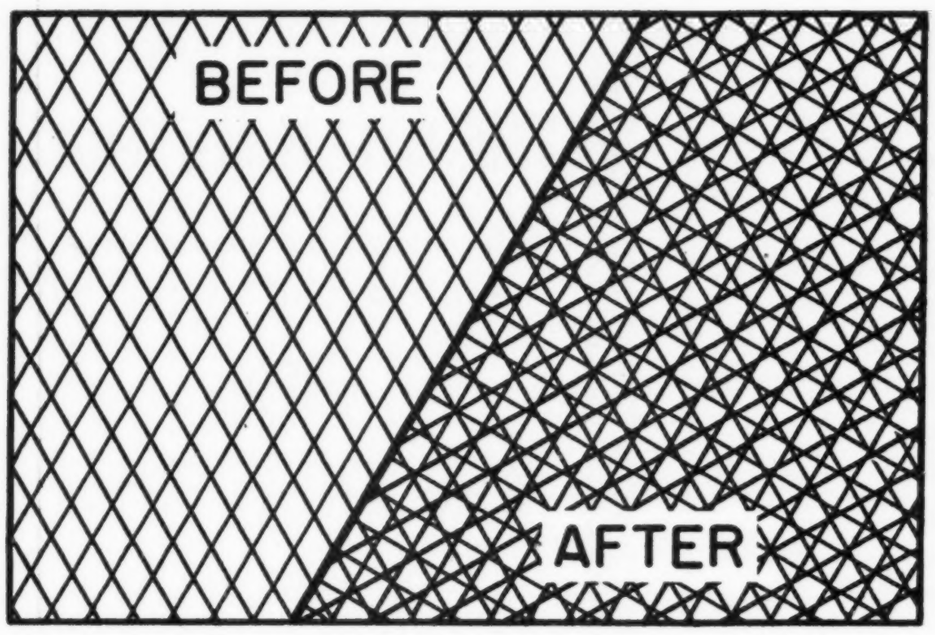

The drawing above shows OKlahoma Glass Fiber Reinforcement before and after the addition of cross-weave reinforcement.

NOW—OKlahoma Glass Fiber Reinforcement has balanced strength in all directions —without sacrificing any of its previously high uniform qualities. This new cross-weave feature means greatly increased transverse strength with longitudinal strength as great or greater than before. The uniform penetration and porosity of OKlahoma Glass Fiber Reinforcement remain the same.

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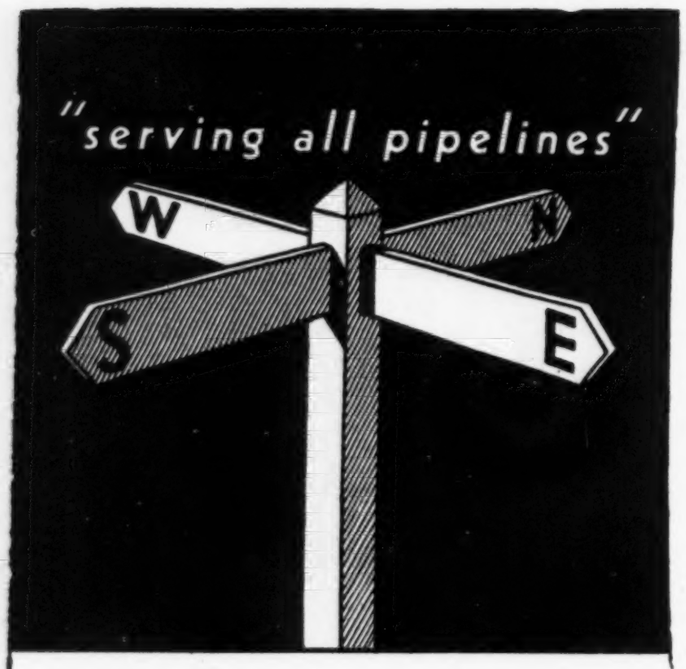

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New England Case Shuffled; Boston Session Starts May 8

The FPC has come forth with a general re-shuffling of the all-inclusive pipeline case centering around Tennessee Gas Transmission Co.'s (Houston) application for facilities to extend its system into New England.

The commission previously had tied in dockets of all companies planning to take gas from Tennessee under the overall construction program. Hearings started March 7. But late in March, the petitions of Erie Gas Service Co., Lake Shore Pipe Line Co., and Grand River Gas Transmission Co. to take Tennessee gas for transport and resale in northern Ohio were split off from the central case. The three companies are vieing for the right to take 17 MMcf from TGT.

Hearings were accordingly rescheduled for April 24.

Last month, the commission further announced that hearings on the application of Northeastern Gas Transmission Co., which would carry TGT gas to city gates in New England, would open May 8 in Boston—at the urgent requests of governors and state regulatory bodies.

The consolidated hearing, including also Transcontinental Gas Pipe Line Corp., another Northwestern supplier; New York State Natural, Niagara Mohawk, and East Tennessee Natural, was recessed to May 2.

The last named has also asked that its application be separated from the general case.

Bechtel Claims World Record

A new world record for heavy pipeline laying was claimed March 23 by Bechtel Corp. when a spread working in the California desert on the Super Inch line for PG&E lined up four miles of 34-in. pipe in a single day.

The spread, under assistant superintendent Fred Yost, is one of two working their way across the Mojave and Tehachapi areas under supervision of Robert Bowman.

100 New Wells In Hugoton

Tascosa Gas Co., Oklahoma City, has started a program to drill 100 wells in the Hugoton gas field of Oklahoma and Texas to supply the system of Michigan-Wisconsin Pipe Line Co., Detroit.

The drilling program will extend over two years. All the wells are to be drilled by Kerr-McGee, Oklahoma City, on a 100-section lease farm-out from the Phillips Petroleum Co. of Bartlesville, Okla.

New Firm To Work Rio Vista

Development and extension of Rio Vista natural gas field east of San Francisco, California's No. 1 dry gas field, comprise the program of the Vistario Corp., a company newly formed by San Francisco financiers.

Henry Hottinger, president of Wertheim & Co., is president of the firm, which announced its intention of exploring presently unproved acreage around the producing area.

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FPC Hears Panhandle Plea To Export Gas To Ontario

While at the western reaches of the international border gas utilities of the United States are working hard to bring about the importation of natural gas from Canada, in the east the Union Gas Co. of Canada Ltd., Ontario, is fighting for a share of gas transported from Texas.

Hearings got under way late in March on the proposal of Panhandle Eastern Pipe Line Co., Kansas City, Mo., which carries Panhandle gas as far as Detroit, to cross the line at the motor city with 27.35 billion cu ft per year—an average of 75. MMcf per day—to supply the Canadian distributor. Panhandle would draw on its own reserves, augmented with purchases from the projected Trunkline Gas Supply Co. Louisiana-Illinois line, to fulfill the contract.

Factors favoring the export included the lack of opposition expressed at the hearings by J. French Robinson, East Ohio Gas Co., Cleveland, who said his company is arranging with Panhandle to assure the adequacy of the gas supply it will receive, and the fact that since April 1946 Panhandle has held a conditional export authorization.

At that time the FPC backed a plant calling for delivery to Union of 5.5 billion per year, provided needs of U. S. customers were met first. Chronic "shortages" which have hindered Panhandle since the war's end prevented the execution of the plan on the scale approved.

Union's general manager, Thomas Weir, says his company has invested $1.5 million to build lines and facilities to get the gas from Detroit to Windsor. Other cities which would benefit include Chatham, London, and Sarnia, all Union properties, and Toronto, Hamilton, Galt, Brantford, and other cities in the area.

Alabama Line Proposed

Ninety-two thousand people in south central Alabama would become users of natural gas under a plan filed with FPC last month for a $2.5 million, 150-mile line. South Central Alabama Natural Gas Co., Birmingham, is the applicant.

Route of the line would originate in Elmore county, where the line would tie in with Southern Natural Gas Co.'s trunk. It would carry 15 MMcf per day to 16 municipalities and surrounding areas, which are presently served LP-Gas.

FPC Speeds Transfer Case

In proceedings involving Independent Natural Gas Co. and Northern Natural Gas Co. regarding Independent's transfer of a compressor station in Gray county, Texas, and a 21-mile line to Northern, FPC last month bypassed intermediate decision procedure to bring about a quick windup.

The case was due to go before the commission after April 17.

The transfer of properties would permit Northern to buy direct from Phillips Petroleum Corp.

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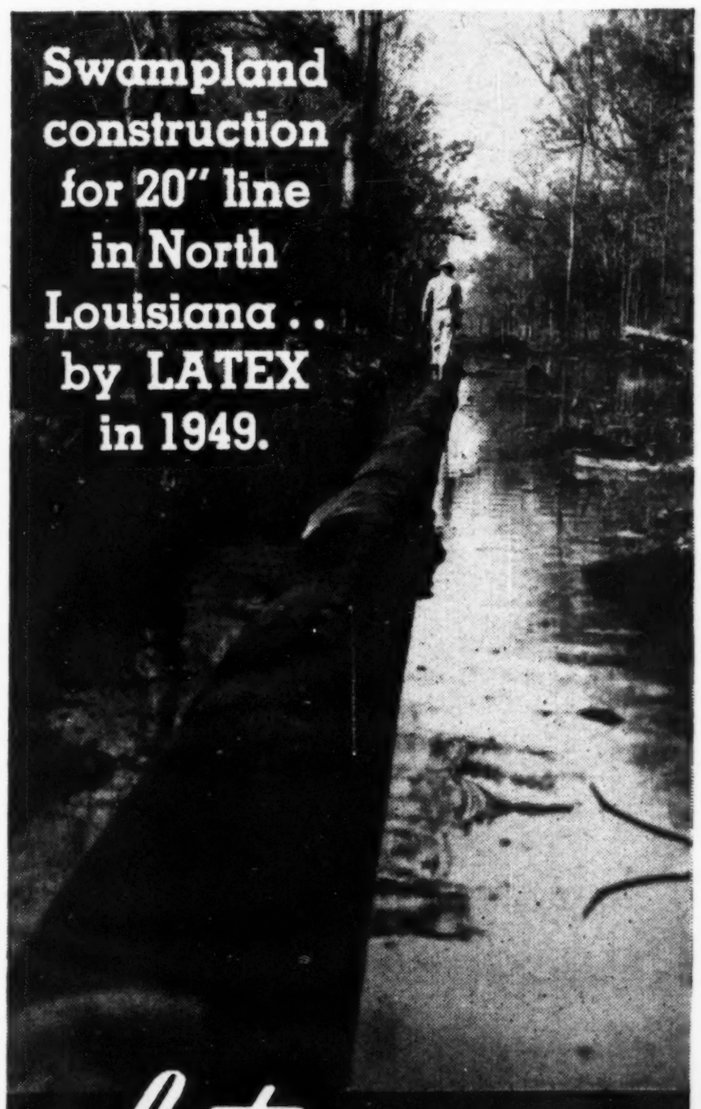

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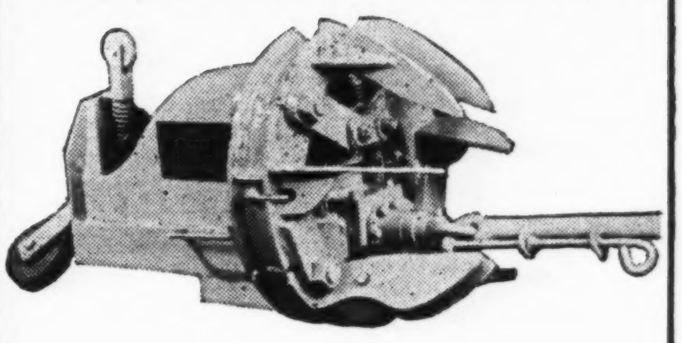

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Texas-Southern Acquires O.C. Whitaker Co.

Texas - Southern Contracting Co., Fort Worth, has acquired the O. C. Whitaker Co. and will continue in the pipeline construction business with the same experienced management, equipment and field organization. O. C. Whitaker Co. was a charter member of the Pipe Line Construction Assn. and had been active in the field of pipeline construction for many years.

Robert Thomas

J. C. Briscoe

President of the new Texas-Southern Contracting Co. is Robert Thomas, formerly associated with O. C. Whitaker. I. C. Little Sr., Dallas, is vice president and J. C. Briscoe, also formerly with O. C. Whitaker, is vice president and secretary-treasurer. J. C. Minyard has been named general superintendent.

First contract on which the new company has started work is for the construction of 92 miles of 30-in. line, designated as Section D, from the Sabine river to Porters, Texas, for Transcontinental Gas Pipe Line Corp.

Texas - Southern will maintain its headquarters at 804 Dan Waggoner building, Fort Worth, formerly headquarters of O. C. Whitaker Co.

More Gas For Phoenix Asked

An extra 35 MMcf per day for Phoenix, Ariz., is the aim of an application recently filed with the FPC by El Paso (Texas) Natural Gas Co., supplier and eastern operator of the Texas-California "Biggest Inch."

Involved in the plan are the construction of 34 miles of line and meter and regulator stations in Pinal and Maricopa counties, Ariz.; the laying of 10 miles of line in Phoenix for transfer to central Arizona Light & Power, Phoenix distributor; abandonment of city gate stations; transfer of 24 miles to Calapco; and acquisition of 12 miles of line in Maricopa county from the utility.

Total cost would run about $867,000. The added supply would come from Permian basin flare gas suppliers.

World's Longest Radio Net

A $1 million micro-wave radio communications system, the world's longest, has been purchased by Transcontinental Gas Pipe Line Corp. for the operation and maintenance of its 1840-mile pipeline now under construction from Mercedes, Texas, to New York City.

General Electric Co. will build the system, which is expected to be in operation by Nov. 15. First delivery of micro-wave equipment is scheduled for early October.